September 1982

DCIEM No. 82-C-62

DYNAMIC TESTING OF THE RELOCATED CT133 BALLISTIC POWERED INERTIAL REEL

D.R. Day

Defence and Civil Institute of Environmental Medicine
1133 Sheppard Avenue West, P.O. Box 2000
Downsiew, Ontario M3M 3B9

DEPARTMENT OF NATIONAL DEFENCE - CANADA

Table of Contents

	Page
List of Figures	iii
Table	v
Summary	vii
1. Introduction	1
2. Test Methodology	
2.1 Selection of Deceleration Pulses	2
2.2 Equipment and Instrumentation	4
3. Data Recording and Processing	6
4. Results	6
5. Conclusions	9
References	10
Attached Appendix A: Belt Load and Inertial Sled Performance Data	15

Auxiliary Appendices:

B. Slides (35-mm) of pre- and post-test sled/seat set-ups for each run

C. Two Polaroid Graph-Check prints taken during the impact for each run

D. Edited 16 mm high-speed movie films of all runs from three cameras

List of Figures

		Page
1.	a. Shoulder Belt Configuration with BPIR in Original Position	11
	b. Shoulder Belt Configuration with Relocated BPIR	11
2.	Recommended Longitudinal Design Crash Pulse as per MIL-S-18471F(AS)	13

Table

Page

1. Summary of Objectives, Test Conditions, and Results 14

Summary

A series of tests on the Canadian Forces CT133 restraint system were carried out using the HyGe crash simulator in the Impact Studies Facility. Six simulated impacts were performed in order to determine the structural integrity of the modified support structure for the Ballistic-Powered Inertial Reel (BPIR) which provides tension for the pilot's two shoulder belts. The BPIR was relocated by DND personnel in order to remove excessive shoulder-belt loading from the pilot's shoulders during ejections or crashes. The deformation of the seat structure near the BPIR was also measured, and the modified BPIR support structure was determined to be sound. In addition, the lock-up capability of the BPIR from the "unlocked" mode of operation was studied, and failure to lock-up was observed at high, but reasonable, deceleration levels.

1. Introduction

The Ballistic-Powered Inertial Reel (BPIR), which is used on many Canadian Forces (CF) jet aircraft ejection seats, acts on the two shoulder restraint belts behind the point at which they come together in back of the airman's shoulders. The BPIR and the shoulder belts have several important functions:

(i) to "haul back" the seat occupant in the event of an ejection, so that the occupant is correctly positioned to minimize injury during the ejection;

(ii) to provide full and continuous restraint, in order to prevent injury to the seat occupant as much as posible, in the event of a car crash; and

(iii) to allow body movements beyond the normal fully-restrained position, at the option of the seat occupant, during relatively-safe aircraft operations, while providing for automatic actuator reel lock-up (which prevents further webbing play-out) in the event of sudden turbulence or an impact.

Function (i) is accomplished by the use of a gas-discharge turbine device attached to the inertial reel, which causes the reel to wind up any slack shoulder restraint webbing once an ejection has been initiated.

During normal flight, the BPIR can function in either of two modes under the control of the seat occupant. In the "locked" mode, the shoulder belt cannot play out of the reel, which satisfies the conditions for Function (ii). In the "unlocked" mode, the shoulder belt can play out of the reel to its maximum limit under constant tension, allowing the occupant to move in order to reach controls or make observations from unusual positions. In addition, in the "unlocked" mode, the BPIR is designed to automatically lock-up whenever the belt webbing undergoes an acceleration of 3 G's out of the reel. This provides a certain minimum degree of protection for the occupant in the event of sudden turbulence or impact; it is not intended to provide protection in the event of an ejection. The "unlocked" mode therefore meets the requirements of Function (iii).

On certain CF aircraft, the shoulder belts pass over the shoulders of larger than average aircrew, join together behind the neck, and enter through the seat back behind and below the top of the occupant's shoulders, as shown in Figure 1a. Therefore, during haul back or an impact, the occupant's spine can be loaded vertically and adversely by the shoulder belts. Consequently, the Aerospace Engineering Test Establishment (AETE) at Cold Lake, Alberta, was tasked to prototype a relocation of the BPIR on various aircraft

ejection seats, beginning with the CT133, in order to remove the shoulder belt loading from the seat occupant's spine. This relocation was accomplished by moving the BPIR up from its normal location as shown in Figure 1a, to the headrest as shown in Figure 1b, so that the shoulder belt passes through the headrest well above the top of the occupant's shoulders.

AETE approached the Impact Studies Facility at DCIEM to conduct dynamic tests on the HyGe sled in order to verify that the structural modifications which had been made were sound, and to measure the structural deformation of the seat structure, during and after impact, at the attachment point of the BPIR within the headrest, for both longitudinal and combined longitudinal-lateral impacts. A secondary objective was to simulate several longitudinal impacts so that the lock-up capability of the BPIR from the "unlocked" mode could also be studied.

2. Test Methodology

2.1 Selection of Deceleration Pulses

The test was executed on the DCIEM 12-inch HyGe impact accelerator which simulates impact by rapid acceleration. The crash deceleration pulse which was delivered to the test package was programmed by the adjustment of various gas pressures and volumes within the impact accelerator, and by the selection of a suitable profile for an internal metering pin. The test sled with its payload was accelerated in a backwards direction to a pre-determined velocity. During this short period of rapid acceleration, the payload on board the sled experienced the same dynamic loads that would occur during a sudden decelerative crash. After the initial acceleration, the sled was slowly decelerated to a stop.

Several different crash deceleration pulses were used during the test series, depending on the specific test objectives. For the primary evaluation of the structural integrity of the BPIR and its deformation measurement during longitudinal impact, the crash deceleration pulse was a compromise between two different specifications and recommendations, both of which concern the dynamic testing of aircrew seats and restraint systems.

The first is a relatively recent military specification (MIL-S-18471 F, System, Aircrew Automated Escape, Ejection Seat Type; General Specification) which gives the deceleration pulse shown in Figure 2, yielding a change of velocity of approximately 59 miles per hour (mph). However, since the relatively old CT133 aircraft ejection seat had not been originally designed to meet this specification, it was decided to retain the peak acceleration requirement of 40 G and to

reduce the change in velocity from 59 mph to one which would correspond to that found in a typical longitudinal impact which would produce a 40-G deceleration.

The determination of this velocity was considerably facilitated by the use of the Aircraft Crash Survival Design Guide (1) and its predecessor, the Crash Survival Design Guide (2). These two extensive reports give a statistical analysis of the impact conditions for various types of U.S. Army rotary and light fixed-wing aircraft which crashed between 1960-65 and 1971-76. While these data are not directly applicable to our current study of jet aircraft restraint systems, there is no similar analysis or guideline for ejection seats, nor any other study from which to draw any more applicable data. Also, the CT133 BPIR utilizes the same inertial reel which is used in many CF helicopters (e.g., the CH135), to which both Crash Survival Design Guides are directly applicable. Any knowledge gained of the lock-up capability of the BPIR in the CT133 is directly applicable, therefore, to the behaviour of the inertial reels used in many CF helicopters.

A total of 650 accidents were investigated in these two reports, and extensive data are presented concerning longitudinal, vertical, and lateral decelerations and their corresponding changes in velocity. These were plotted in order to show their various inter-relationships and, of more importance, to show the "percent cumulative frequency of occurrence" of all potentially survivable accidents as a function of acceleration and changes in velocity.

Using the data from these two references, a 40-G longitudinal impact acceleration (called for by MIL-S-18471 F) corresponds to a 97% cumulative frequency of occurrence, which in turn, corresponds to a velocity change of 37 mph; these nominal values of acceleration and velocity were used only for the tests concerning the structural integrity of the BPIR modification and the measurement of its deflection during longitudinal impact. For safety considerations, a preliminary impact with reduced peak acceleration and velocity was first carried out in order to reduce the possibility of an unexpected, catastrophic seat failure.

Since Military Specification MIL-S-18471 F did not give any lateral impact specifications, the Crash Survival Design Guides described earlier (1, 2) were used to select a compatible peak impact acceleration and change of velocity for the combined longitudinal-lateral impacts using data for a 95% cumulative frequency of occurrence (i.e. 95% of all potentially survivable accidents resulting in impact would involve impact accelerations and changes of velocity below those selected). This particular value was selected because it is the acceleration level for which both Crash Survival Design Guides recommend that restraint systems be designed. The data yielded a peak acceleration of 44 G and a change of velocity of 34 mph. As before, a

preliminary test was carried out with reduced peak acceleration and velocity in order to reduce the possibility of an unexpected seat failure.

In the study of the lock-up capability of the BPIR, the specific objective was to determine whether or not the BPIR could fail to lock-up from the "unlocked" mode and, if so, at what sled acceleration and velocity-change levels this would occur. From this, the "percent cumulative frequency of occurrence" plots in the Crash Survival Design Guides (1, 2) could then be consulted in order to determine the significance of any lock-up failure. Such failure is likely unimportant if it occurs only at extremely high deceleration levels (i.e., levels above which most aircrew could not be expected to survive in any event). However, if BPIR failure were to occur at relatively low deceleration levels (ones which aircrew could be expected to survive), it would be of extreme importance since BPIR failure could lead to unnecessary injury or death.

Consequently, the Crash Survival Design Guides (1, 2) were consulted, and a sled acceleration and velocity-change level were selected for the first test in this portion of the program, based on past experience at DCIEM with BPIR performance. The nominal values chosen were 12 G of acceleration with a velocity of 23 mph, using a 75% cumulative frequency of occurrence. In an attempt to "bracket" the failure point of the BPIR, at least one subsequent test at a slightly higher frequency of occurrence was planned if the BPIR did not fail the first test; alternatively, another test at a lower frequency of occurrence was planned if the BPIR failed the first test.

2.2 Equipment and Instrumentation

A CT133 aircraft ejection seat was supplied by AETE for the test series, along with several new and used headrest assemblies. The seat had been subjected to a variety of tests at AETE before being shipped to DCIEM, but had suffered no significant structural damage which could be expected to effect the validity of the results obtained from the DCIEM tests.

The occupant of the ejection seat was an uncertified 95-percentile adult anthropomorphic crash-test dummy (Alderson Research Labs, Stamford, Connecticut, U.S.A.; Model VIP-95, Serial No. 158, conforming to the United States Code of Federal Regulations (3)). It was instrumented in the chest and head cavities with Endevco type 7267C-750 triaxial accelerometers (Serial No. BA38 and AA17 respectively) in order to monitor chest and head decelerations during the impact. The accelerometers were orientated within the dummy along three orthogonal axes such that positive X was in the direction from the back to the front of the dummy, positive Y was in the direction from the right side to the left, and positive Z was in the direction from the feet to the head.

The dummy was clothed in a Canadian Forces summer flying suit provided by the Medical Life Support Division (MLSD) of DCIEM, and new seat belt restraint systems were supplied by AETE. Several new BPIRs were also supplied by AETE; however, only the "lock-up capability" tests were performed with new BPIRs in each case, in order to ensure optimum BPIR performance. For other tests with the BPIR in the "locked" mode, both new and used BPIRs were used.

The load on the shoulder belt webbing was measured using a "Lebow" model 3419 belt load cell (Serial no. 328 for the first two runs; no. 411 for the remaining runs).

Basic sled acceleration data were monitored using two Setra model 141 high output accelerometers which were mounted directly on the impact sled.

One ruggedized high-speed Stalex rotating prism camera was mounted on an outrigger beside the ejection seat, providing a lateral view of the seat. This camera was equipped with a 13-mm wide-angle lens and was operated at a speed of 1000 frames per second. In addition, one Locam pin-registered camera was positioned on the laboratory floor, in order to provide an oblique angle view of the impact. This camera was also equipped with a wide-angle lens, but operated at a speed of 500 frames per second.

In order to determine the maximum belt pullout from the reel and the maximum displacement of the seat and headrest at the BPIR attachment point during the impact, a third high-speed movie camera was mounted beside and very close to the headrest, so that it sighted along the face of the headrest. A calibrated scale was filmed first and was later used to determine the maximum seat displacement, and the maximum and final headrest displacements. Both Stalex and Locam movie cameras were used for this measurement on different runs.

Two Graph-Check sequence cameras were set up so that "quick-look" photographs of events during the impact were available. These cameras take eight separate photographs at pre-selected equal intervals on a single sheet of Polaroid film, for viewing immediately after the impact.

Before and after each run, photographs were taken of the sled and seat set-up. The photographs were identified by a run number within each frame according to the following table:

Run No.	Frame Designation Number
371	1
372	2
373	3
374	4
375	5
376	6

3. Data Recording and Processing

The output from the accelerometers was amplified on board the sled using a series of specially designed, ruggedized, low-noise preamplifiers. The signals were analog filtered at 5 kHz on board the sled and were then transmitted along a low noise, flying-lead umbilical cable to the recording and data reduction area, where they were stored in the memories of a multi-channel transient recorder (Datalab, Surrey, UK). The transient recorder equipment digitized the input signal from each channel synchronously with every other channel at a sampling rate of 10 kHz. The digitizer accuracy was 10 bits (1 part in 1024) and the total recording time of the digitized data was 0.4 seconds, which was long enough to capture all significant impact and rebound inertial and belt load data. Complete details of the Impact Studies Facility's data acquisition system may be found in Reference 4. The digitizer and recorder equipment specifications are more stringent than the requirements established by the Society of Automotive Engineers (SAE) which sets standards for instrumentation for dynamic test purposes (5).

Immediately after firing the sled, the data were transferred to a computer disk for processing. (The raw data for all runs are being retained on magnetic tape in the DCIEM computer center on an indefinite basis.) The computer programs first performed digital filtering on the data according to the SAE specification (5) which details the specific filtering to be carried out on signals emanating from various sources. For these tests, the sled, chest, and head accelerations were recorded, as well as the belt load force. The inertial data were appropriately filtered, as specified, at 60 Hz, 180 Hz, and 1000 Hz, respectively. The belt load force was filtered at 60 Hz. The data were then scaled and the resultant chest acceleration computed, along with the sled displacement and velocity, by successive integration of the sled acceleration. Appropriate graphs were then produced by a plotter under the control of the computer.

4. Results

Complete inertial data from the sled, dummy head and chest and

shoulder belt loads are given in Appendix A. The data are grouped in chronological order by run number; on the plot pages the run number is given by the last three digits of the numerical portion of the heading found at the top centre of all pages numbered "1", or at the top left corner of all pages numbered 2, 3, and 4; e.g., the page headed by DK:T33371.DAT gives data for Run 371. For each run, the inertial plots are presented in the follower order:

Page 1, sled displacement, velocity, and acceleration

Page 2, head acceleration in the X direction
head acceleration in the Y direction
head acceleration in the Z direction
resultant head acceleration

Page 3, chest acceleration in the X direction
chest acceleration in the Y direction
chest acceleration in the Z direction
resultant chest acceleration

Page 4, shoulder belt load

The maximum value of each plot is printed above, and at the right end of each plot. The data have been summarized and are presented in Table 1 along with an analysis of the data from the high-speed motion-picture camera films (i.e., maximum belt pull-out, maximum dynamic seat and headrest displacements, and the final headrest displacement). The objective of each run is also given in the table.

The column entitled "maximum belt pull-out" in Table 1 gives the maximum amount (in inches) by which the shoulder belt webbing pulled out of the BPIR during the impact. This is the sole method for determining whether or not retractor lock-up failed (as shown by "Full", 14.5 in, pullout values), and is determined from the film taken by the high-speed camera located next to the headrest. The same camera is used to determine the maximum dynamic headrest and seat displacements.

The following notes and observations from each run should be considered along with the tabular results:

Run 371

This was a preliminary run intended to lead up gradually to the structural integrity/deflection test on the next run and, to a lesser degree, to observe retractor lock-up capability. The BPIR apparently failed completely to lock-up during this impact, as the full 14.5 inches of belt were pulled out of the BPIR. The lap belt also broke during this run. In addition, the belt load-cell and accelerometer

transducer cables disconnected early during the acceleration, probably before the actual peak belt load was attained. Therefore, the actual peak belt load would actually be higher than the value shown in the table.

Run 372

For this run, at the correct peak acceleration and velocity-change levels specified earlier for the structural integrity/deflection test (i.e., nominally 40 G and 37 mph), the BPIR was locked to prevent interference from a possible "failure-to-lock" malfunction. The small belt pull-out measured (i.e., 2.5 inches) is normal and is due to both webbing stretch and slack on the reel. During this impact, the lap belt buckle came apart and the lap belt broke its connection to one side of the seat. Also, as in Run 371, the transducer cables disconnected early during the acceleration. Therefore, the actual belt loads could again have been higher than the value shown in the table. Consequently, in order to obtain more complete belt load and inertial data, this run was repeated (see Run 373).

Run 373

This run fulfilled all the requirements for the structural integrity/deflection test and no data were lost due to disconnection of the transducer cables. The shoulder belt tore its stitching completely at the neck and came apart, the lap belt buckle came apart, and the lap belt broke its connection to one side of the seat.

Run 374

This was the first test made to study the lock-up capability of the BPIR from the "unlocked" mode. The arbitrary acceleration level chosen produced a complete failure of the BPIR to lock-up: full belt extension of 14.5 inches was observed.

Run 375

This second test of BPIR lock-up capability showed that, at a reduced acceleration level, the BPIR locked-up successfully.

Run 376

This was a preliminary test leading up to a more severe simulated impact as required for a combination longitudinal-lateral structural integrity/deflection test. Since the seat shell detached from its framework during this acceleration, and minor repairs to the seat (which had been carried out after previous runs) could not have restored it to its former structurally sound condition, another test at a higher acceleration level could not be carried out.

5. Conclusions

Of the longitudinal impacts for structural integrity and deflection measurement (i.e., Runs 371-3), Run 373 met all of the specified test requirements for acceleration and change in velocity. Also, the values obtained for maximum dynamic and final headrest displacement (1.4 and 0.7 inches respectively) should represent the ultimate maximums which could ever be achieved by this type of testing, since a variety of restraint hardware items and the shoulder-belt stitching failed during the impact. It would be very difficult to apply a greater load to the BPIR and headrest at the acceleration levels used for dynamic testing.

The combined longitudinal-lateral impact (Run 376) which resulted in gross distortion and failure of the seat indicates that, for this angle of impact, the seat was not designed to withstand anywhere near the severity of impact demanded by newer seat specifications.

The tests of the retractor lock-up capability (Runs 374 and 375) indicate that the BPIR has a serious shortcoming, in that it begins to fail to lock-up from the "unlocked" mode at an acceleration level somewhere between 8 and 13 G. This finding should be explored further, since the specification for the BPIR does not define any maximum impact deceleration above which the BPIR is not expected to function correctly (i.e., to lock-up) from the "unlocked" mode (6, 7). Also, a deceleration of 8-13 G corresponds to a cumulative frequency of occurrence (of potentially-survivable crashes) of between 65% and 75%, which is considerably lower than the 95% which the Crash Survival Design Guides recommend for all new restraint system designs (1, 2).

References

1. LAANANEN, D.H. "Aircraft Crash Survival Design Guide: Vol. II - Aircraft Crash Environment and Human Tolerance." by Simula Inc. for the U.S. Army Research and Technology Laboratories, Report No. USARTL-TR-79-22B, Jan. 1980

2. "Crash Survival Design Guide," by Dynamic Science Engineering Operations for the U.S. Army Air Mobility Research and Development Laboratory, Report No. USAAMRDL-71-22, Oct., 1971

3. "Part 572 - Anthropomorphic Test Dummies," in Code of Federal Regulations, Title 49: Transportation, The Office of the Federal Register, National Archives and Records Service, General Services Administration, Washington, DC, U.S.A. pp 421-443, 1981. (49CFR 572)

4. BOWDEN, T.J., J.K. REICHERT, AND J.P. LANDOLT, "The Data Acquisition System at the DCIEM Impact Studies Facility, in Passenger Car Meeting, Society of Automotive Engineers, Inc., Warrendale, PA, U.S.A., June 8-12, 1981. (SAE Paper No. 810812)

5. "SAE Recommended Practice J 211 1980 - Instrumentation for Impact Tests," Society of Automotive Engineers Inc., Warrendale, PA, U.S.A., 1980

6. Military Specification: Reel, Shoulder Harness, Inertial Lock. MIL-R-8236D, Dec. 1975

7. Technical Manual: Overhaul Instructions with Illustrated Parts Breakdown. No. T.O. 13A4-20-3, Oct. 1972

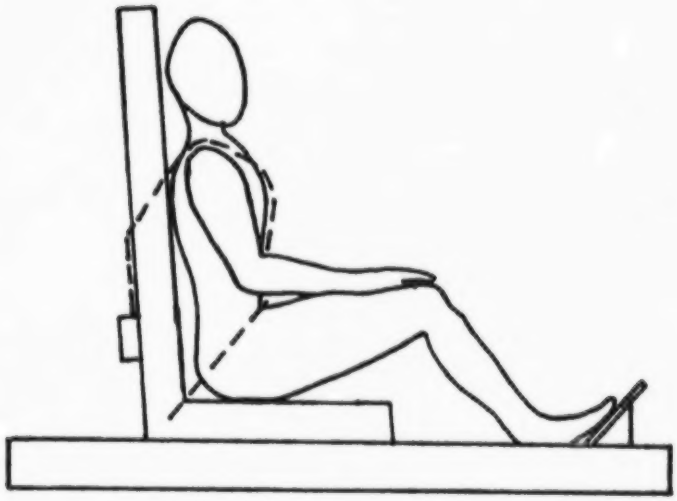


Figure 1A: Shoulder Belt Configuration with BPIR in Original Position

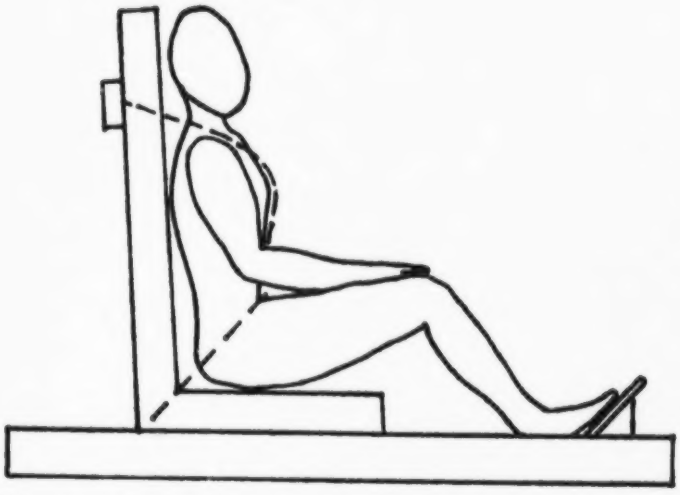


Figure: 1B: Shoulder Belt Configuration with Relocated BPIR

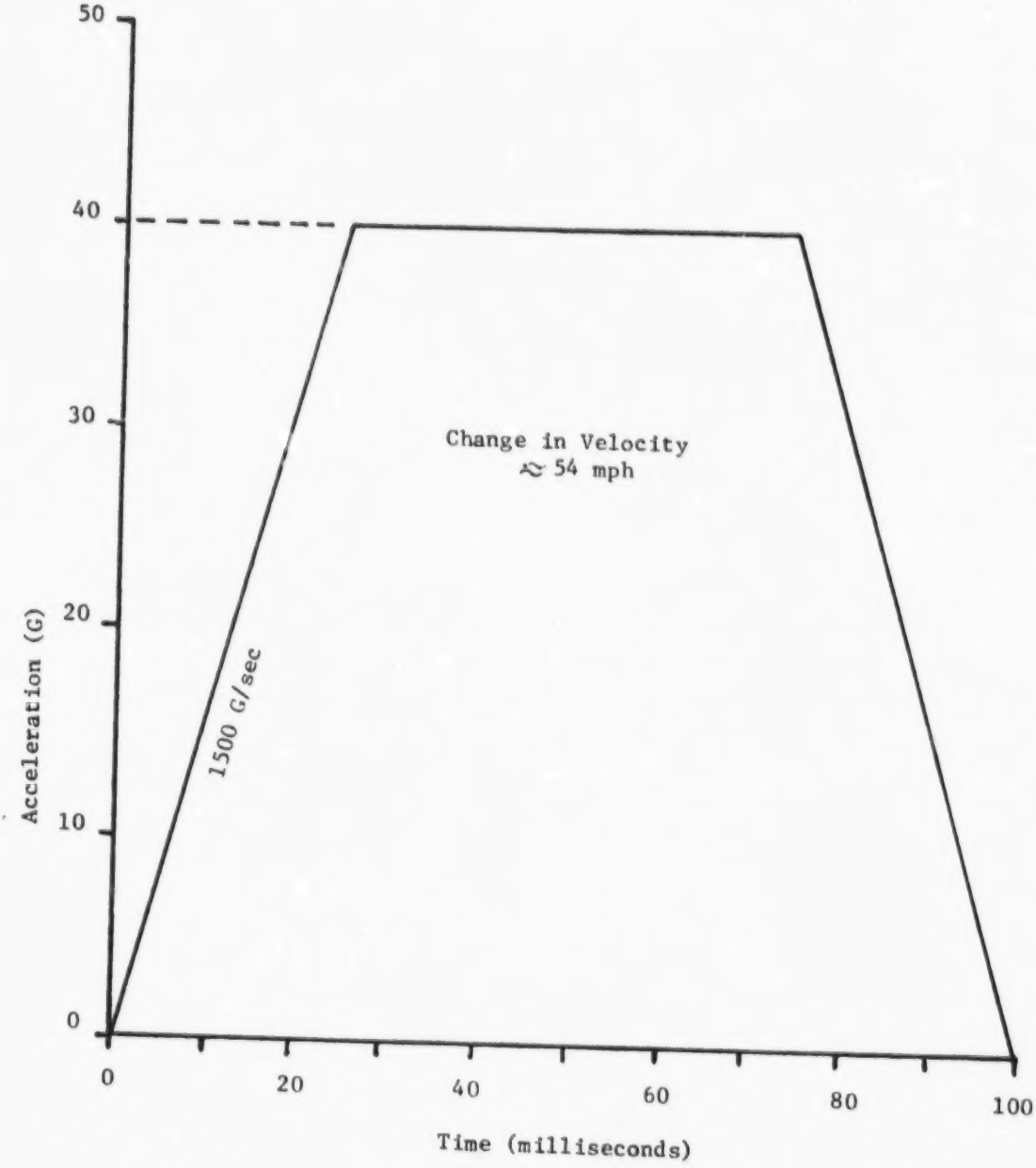


FIGURE 2: Recommended Longitudinal Design Crash Pulse as per MIL-S-18471F(AS)

Table 1. Summary of Objectives, Test Conditions, and Results

OBJECT OF TEST	RUN NO.	PEAK ACC.	VELOCITY (mph)	INITIAL RETRACTOR CONDITION: LOCKED (L) UNLOCKED (U)	PEAK SHOULDER BELT LOAD (pounds)	MAX. BELT PULL-OUT (inches)	MAXIMUM DYNAMIC SEAT DISPLACEMENT (inches) *	HEADREST DISPLACEMENT (inches) + MAXIMUM DYNAMIC	FINAL
Determination of integrity and maximum deflection of headrest (Frontal Pulse)	371	31	32	U	2190	14.5 (Full)	1.1	1.0	0.6
	372	40	36	L	3540	2.5	1.2	1.1	0.7
	373	40	36	L	3610	3.0	0.7	1.4	0.7
Study of retractor lock-up capability	374	13	22	U	1210	14.5 (Full)	0.2	0.6	0.2
	375	8	17	U	1450	3.0	0.3	0.6	0.4
Determination of integrity and maximum deflection of headrest (45° pulse)	376	35	31	L	3100	3.0	0.8	1.6	1.4

* relative to the sled, opposite to the direction of sled motion, and measured at the bottom edge of the headrest.

relative to the seat, opposite to the direction of sled motion, and measured at the bottom edge of the headrest, at its centerline.

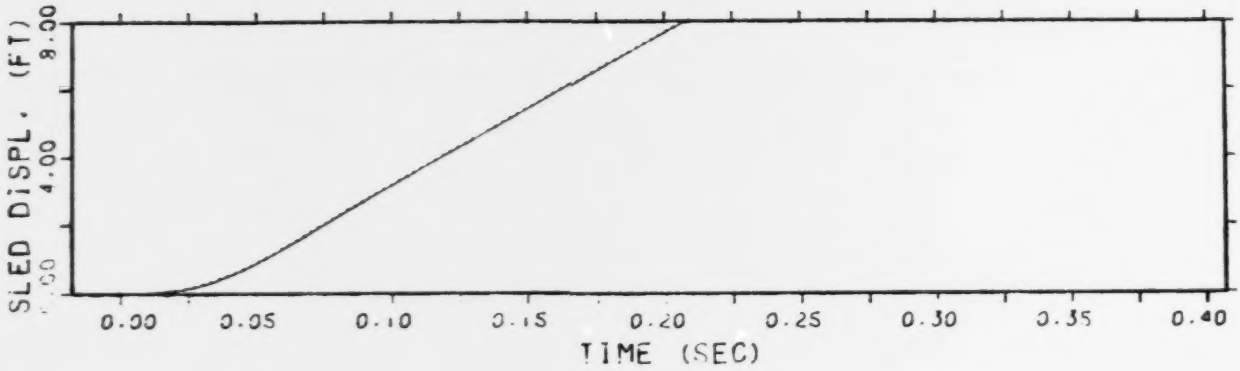
Appendix A

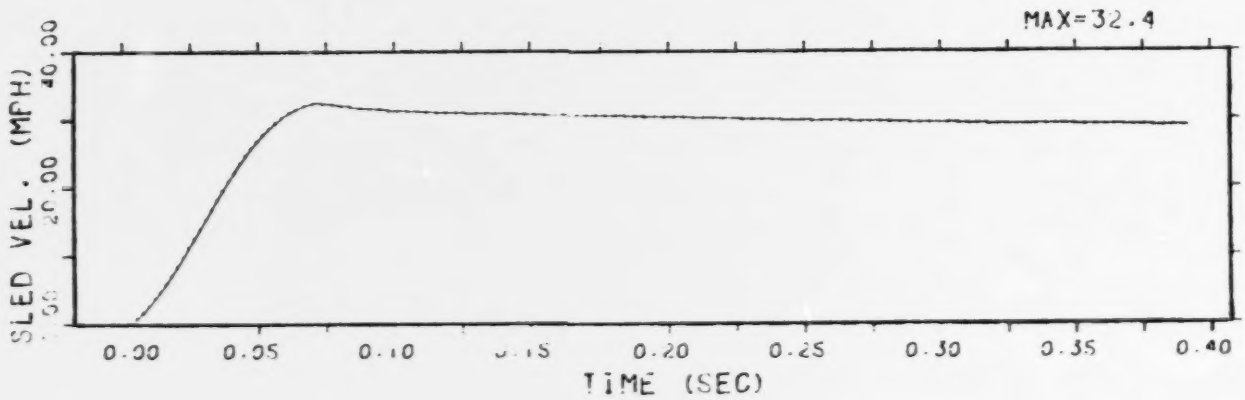
Belt Load and Inertial Sled Performance Data

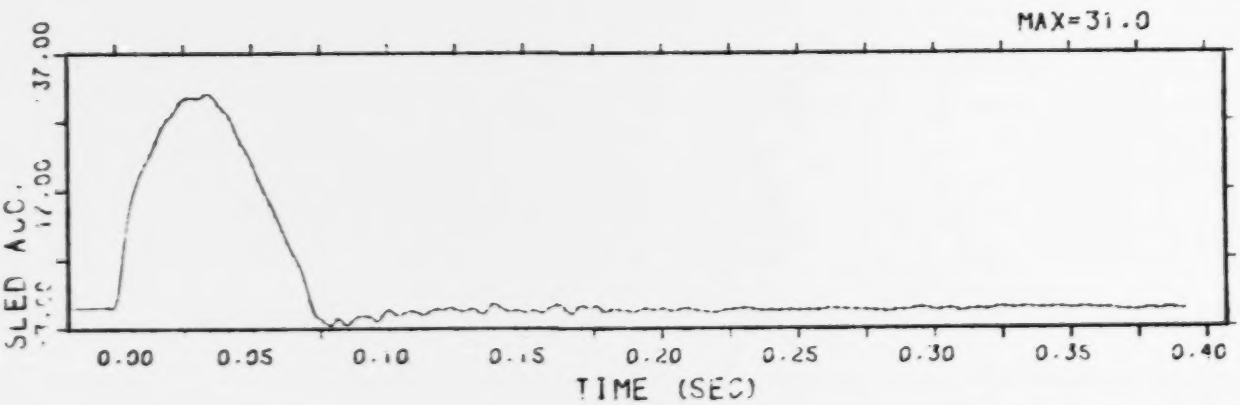
DCIEM IMPACT STUDIES FACILITY

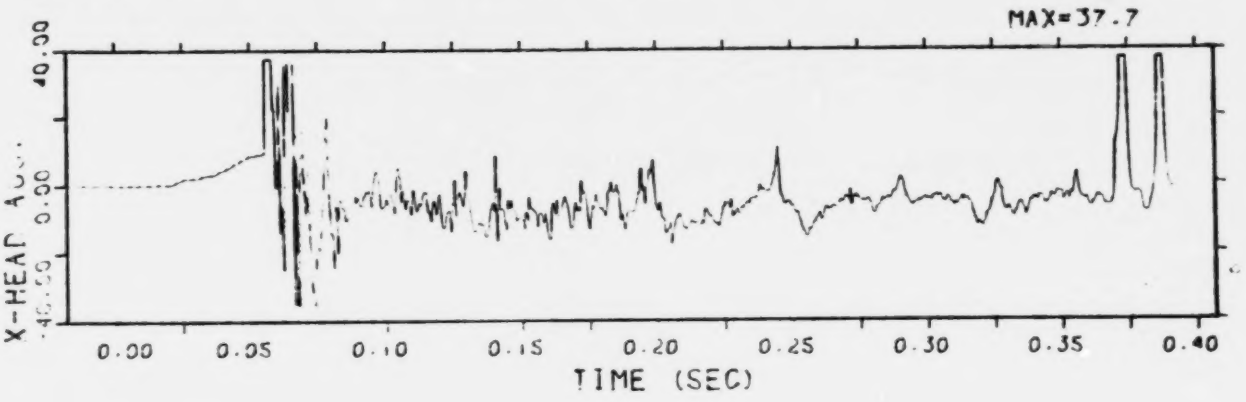
DK:T33371.DAT

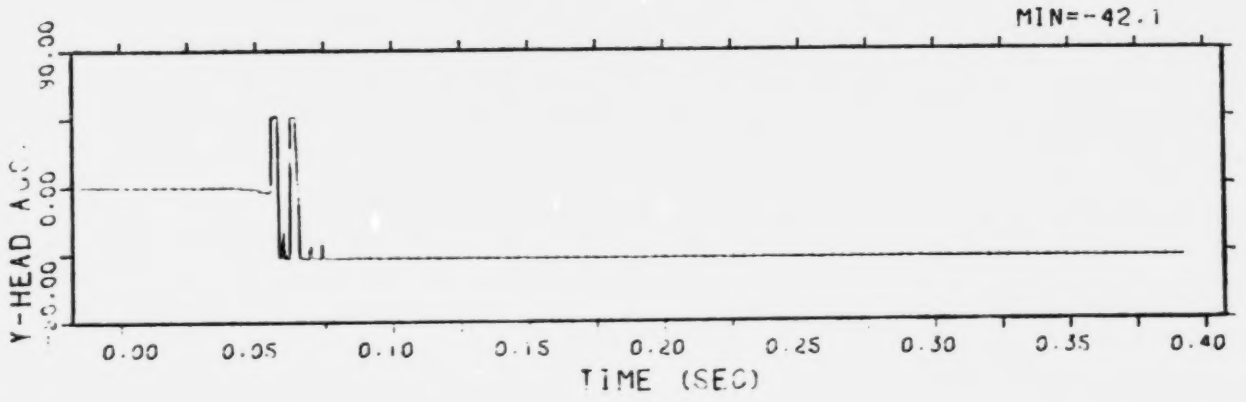
19-AUG-82

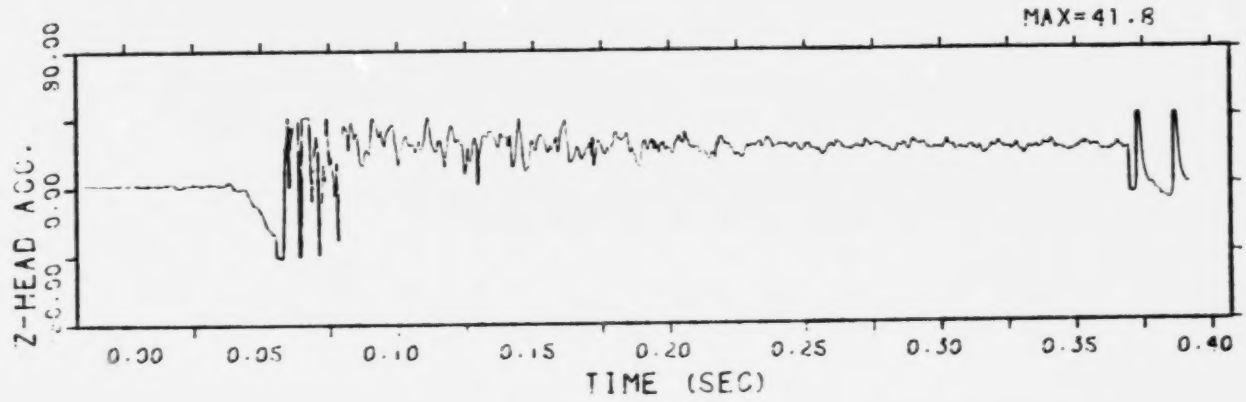


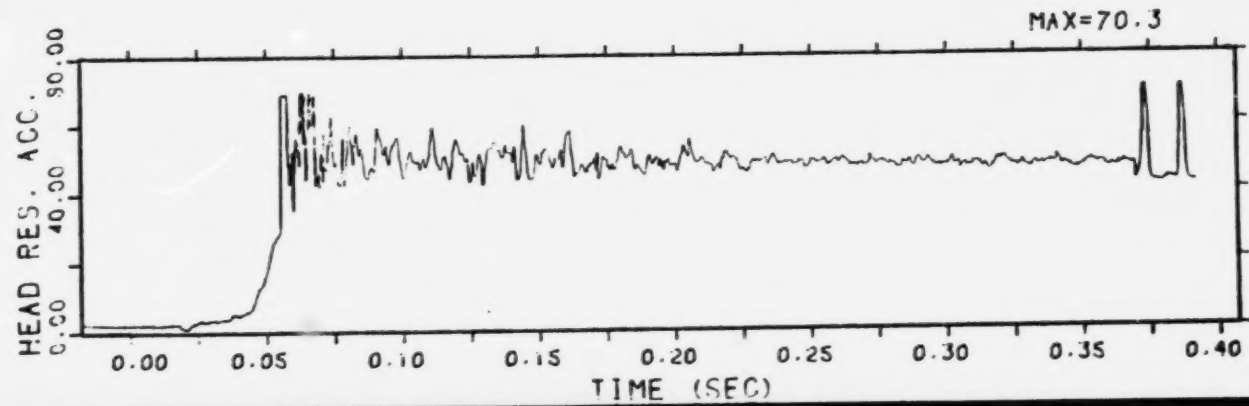


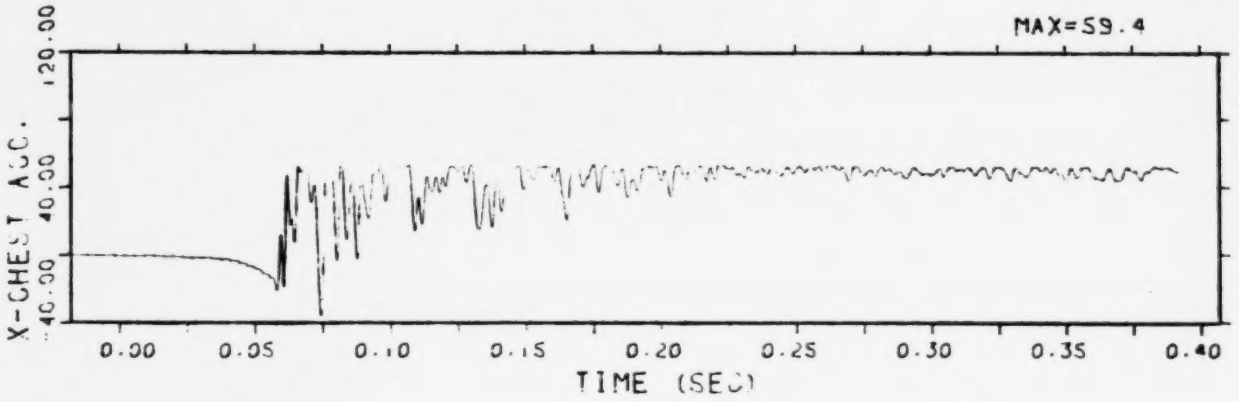


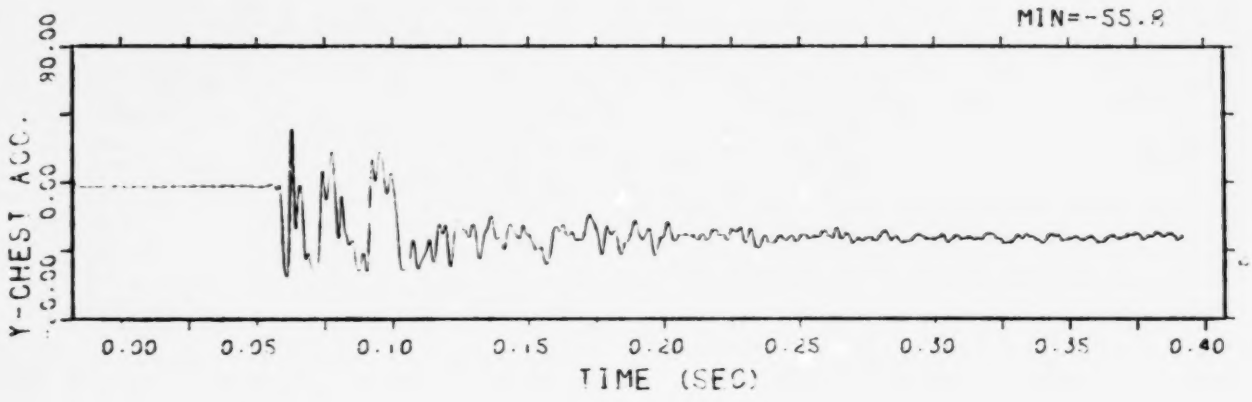

MAX=37.7
40.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

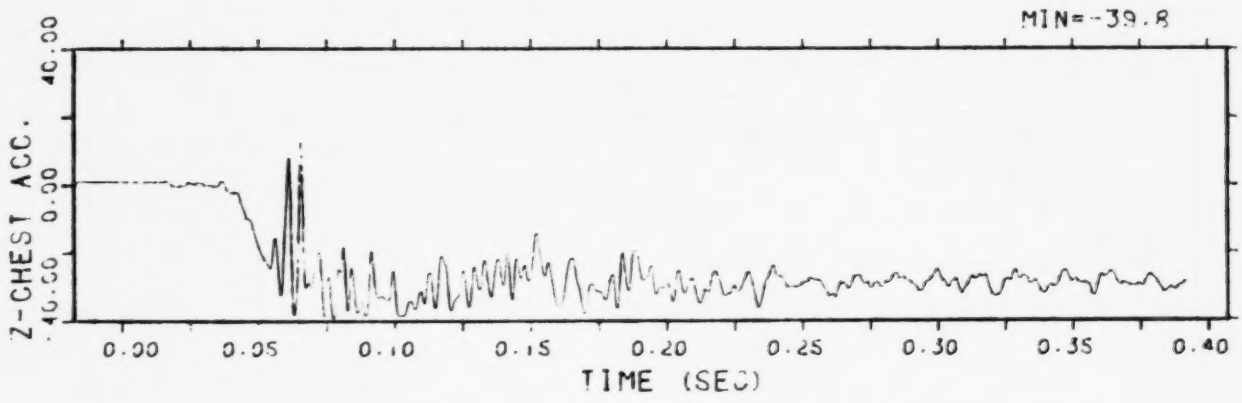

MIN=-42.1
90.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

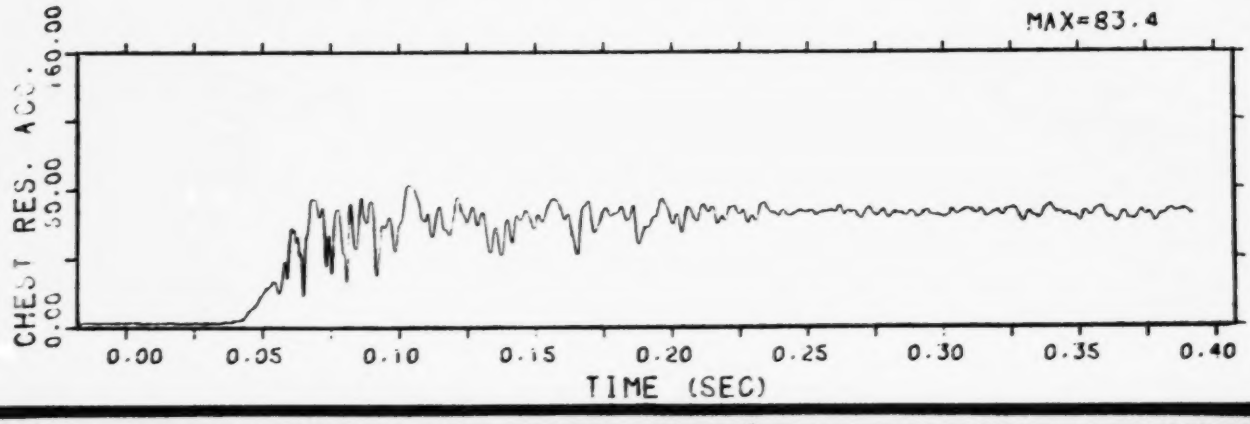

MAX=41.8
90.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

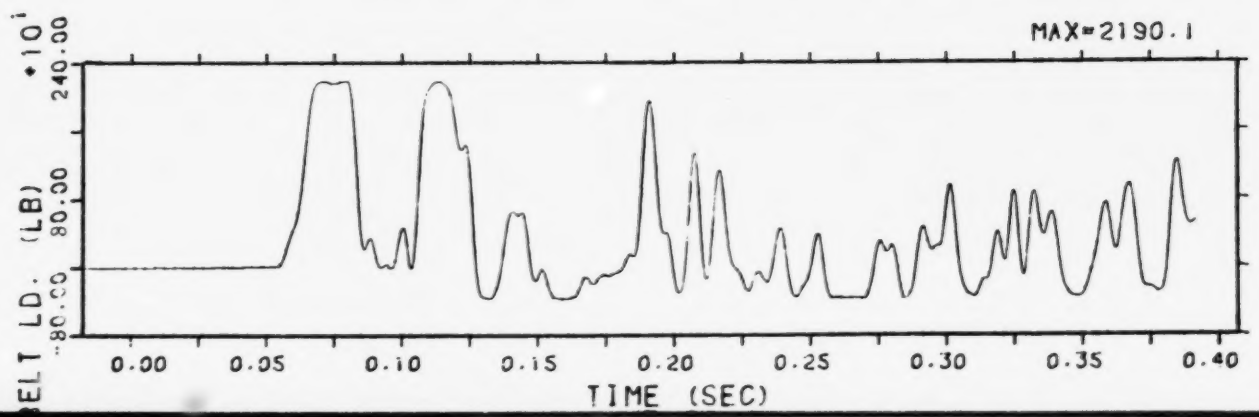

MAX=70.3
90.00
40.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)


MAX=59.4
X-CHEST ACC.
120.00
40.00
-40.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)


MIN=-55.8
Y-CHEST ACC.
80.00
0.00
-80.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)


MIN=-39.8
Z-CHEST ACC.
40.00
0.00
-40.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

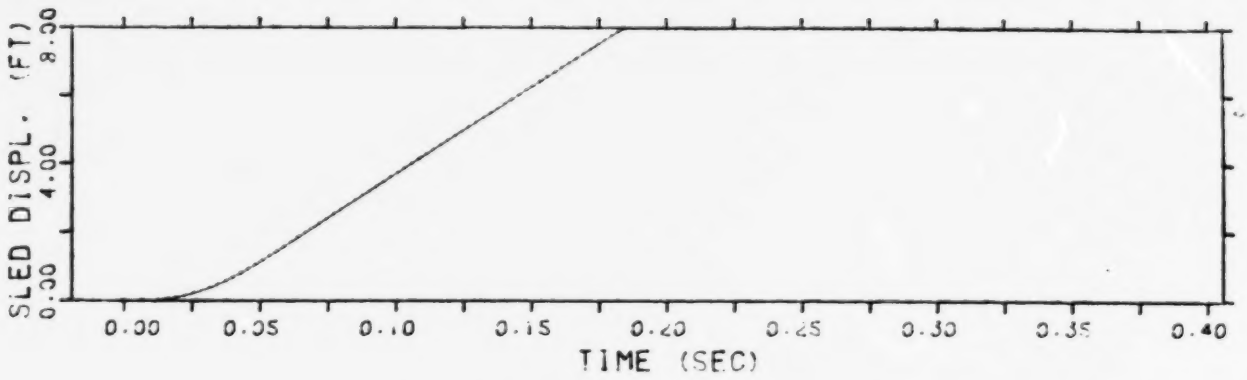

MAX=83.4
CHEST RES. ACC.
160.00
80.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

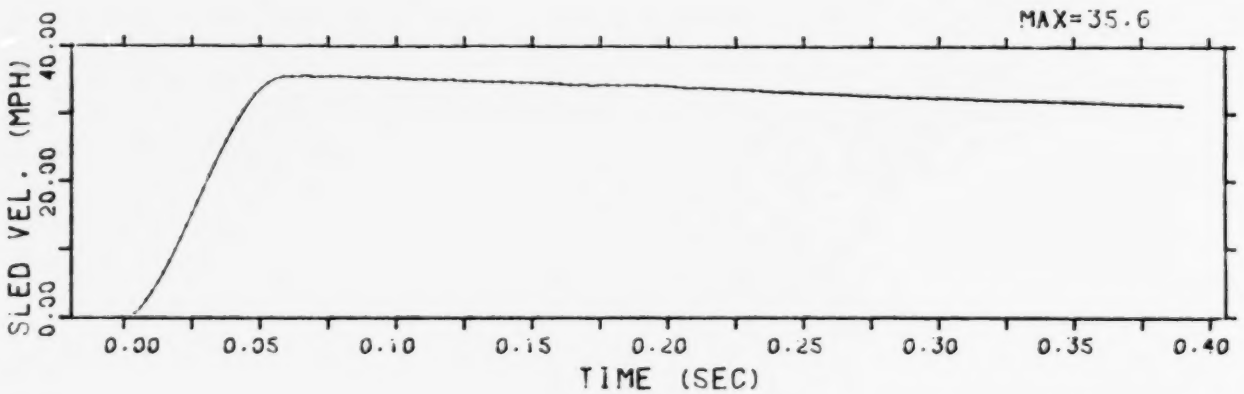

MAX=2190.1
•10³
240.00
80.00
-80.00
ELT LD. (LB)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

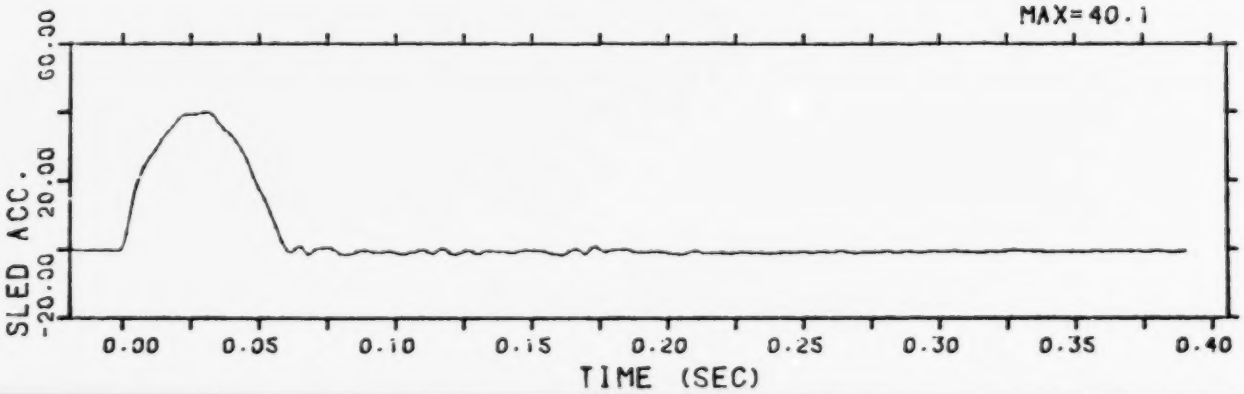
DCIEM IMPACT STUDIES FACILITY

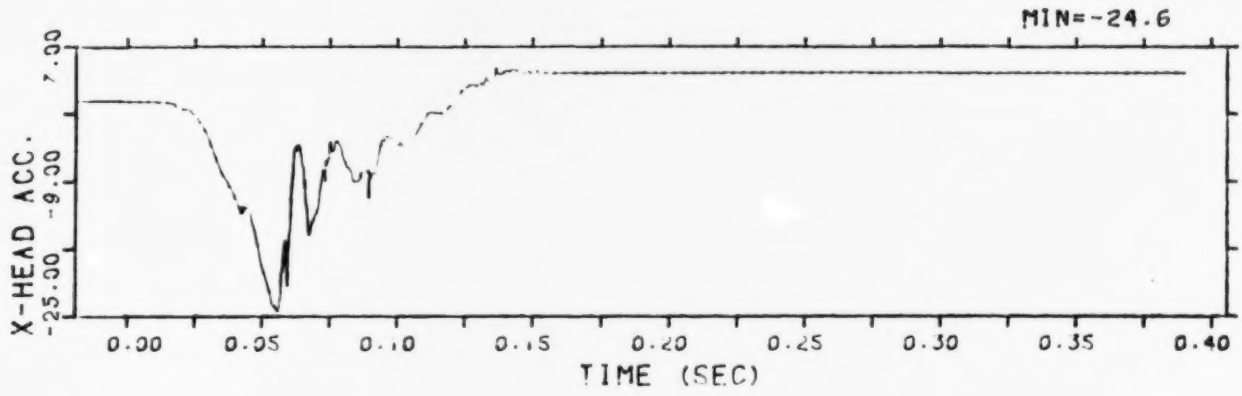
DK:T3F372.DAT

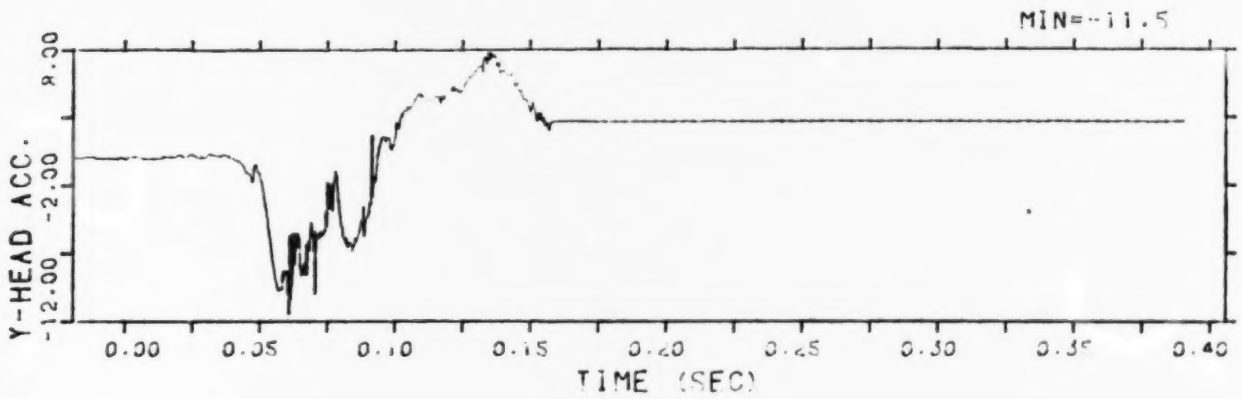
23-AUG-82

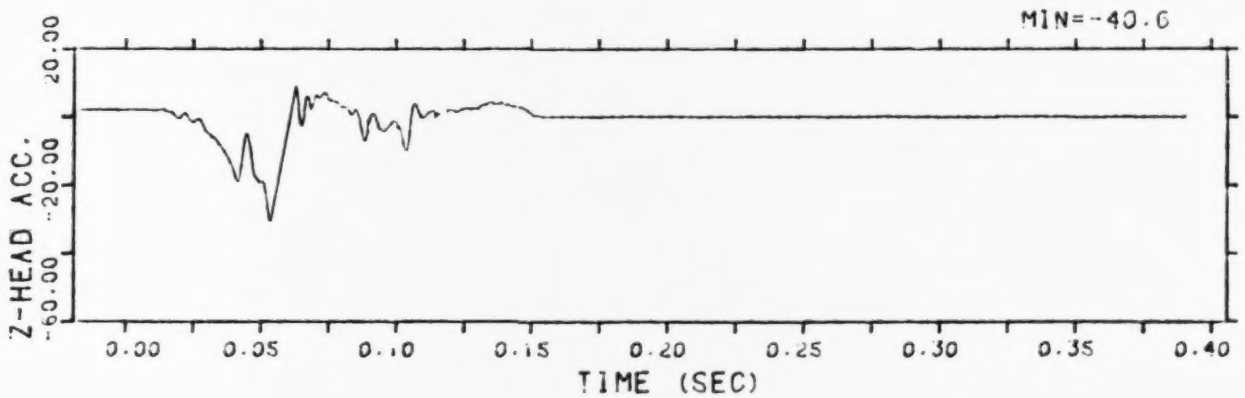


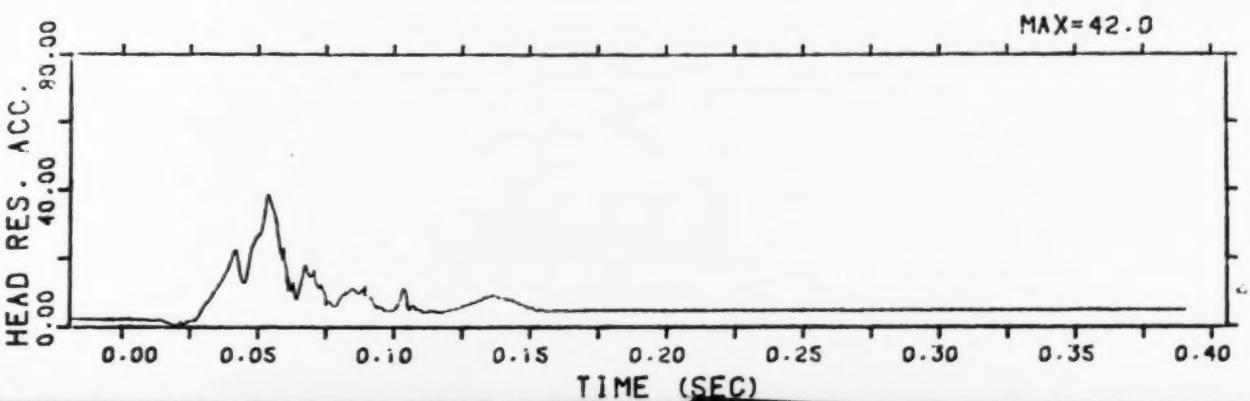





MIN=-24.6
X-HEAD ACC.
7.00
-9.00
-25.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

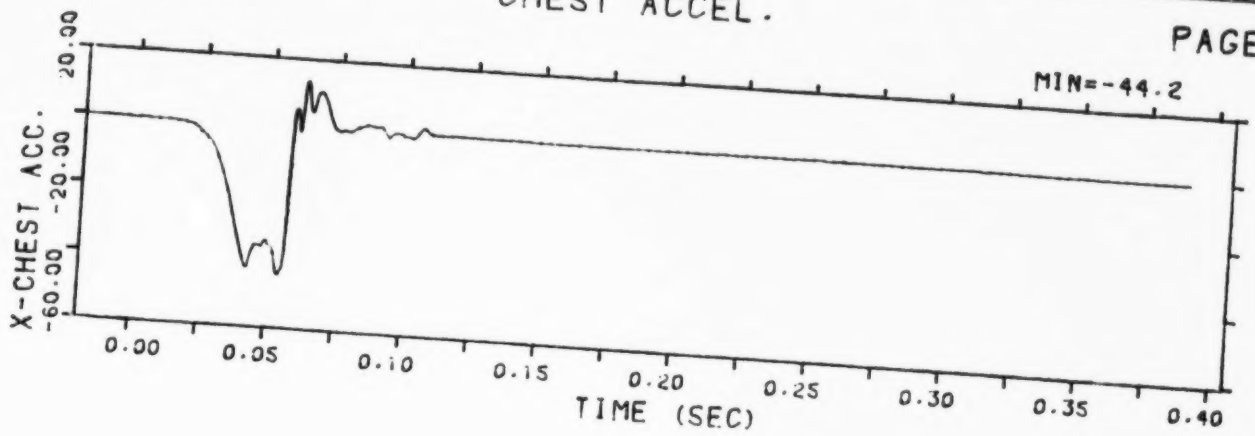

MIN=-11.5
Y-HEAD ACC.
8.00
-2.00
-12.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

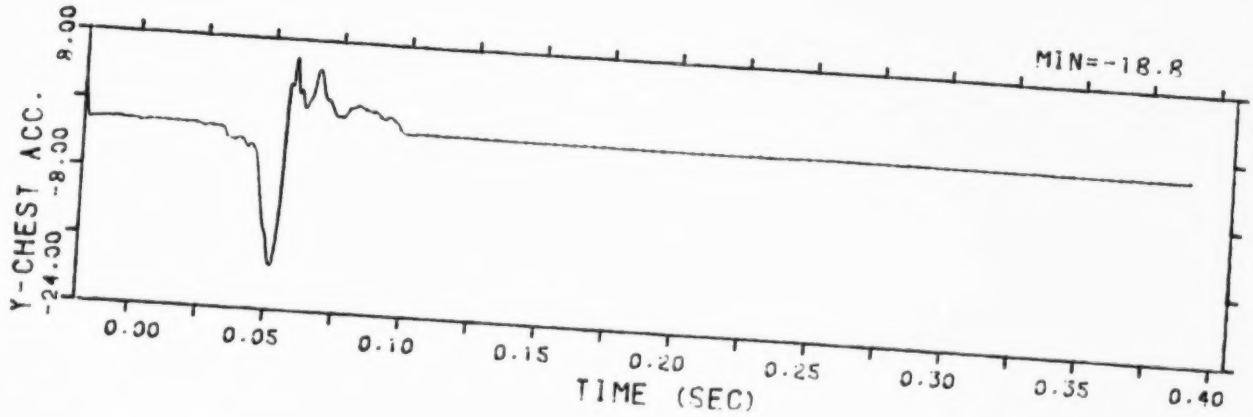

MIN=-40.6
Z-HEAD ACC.
20.00
-20.00
-60.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

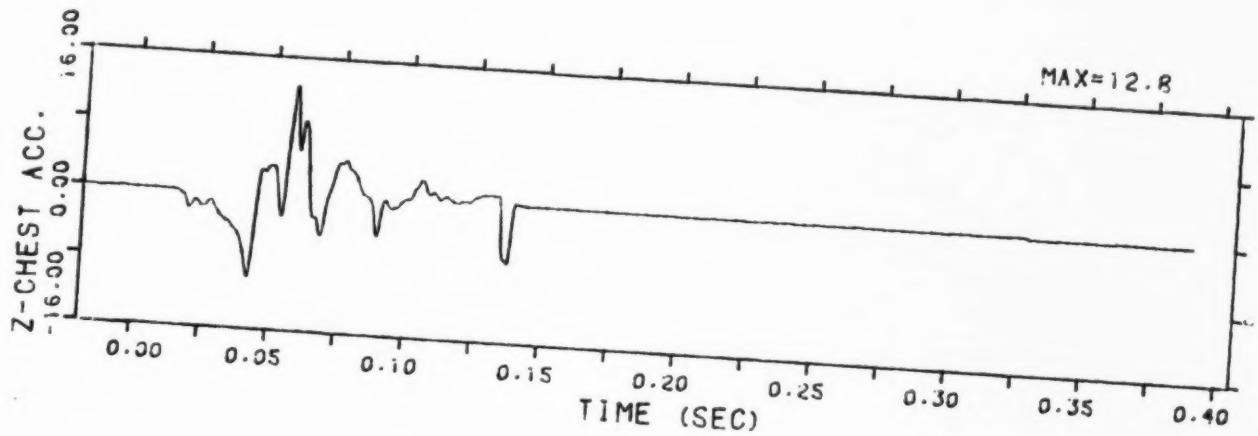

MAX=42.0
HEAD RES. ACC.
80.00
40.00
0.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

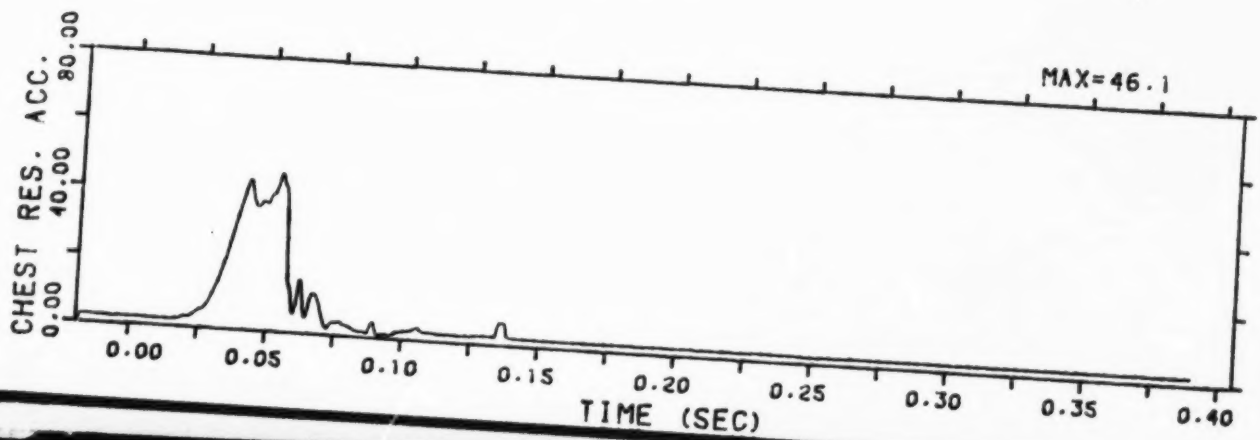
DK:T3F372.DAT

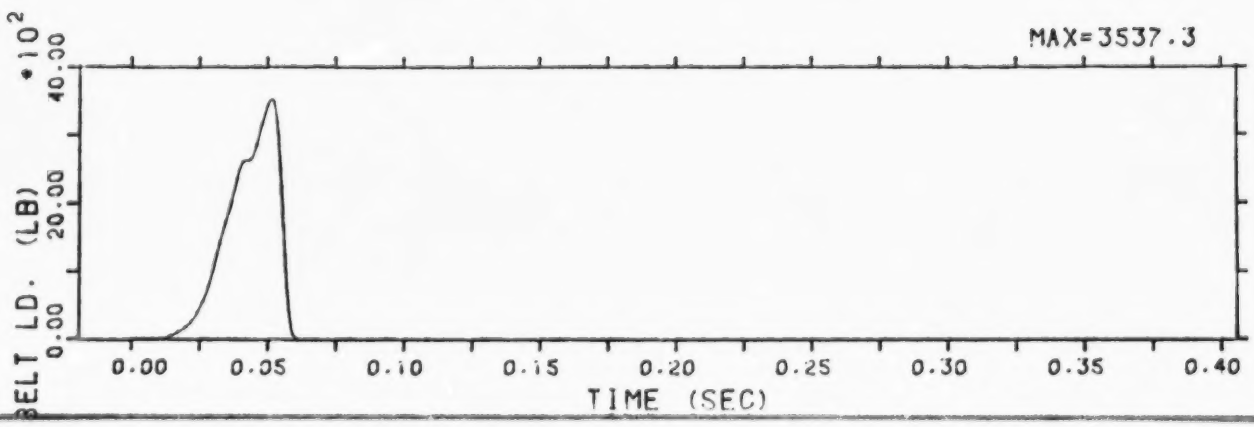
CHEST ACCEL.







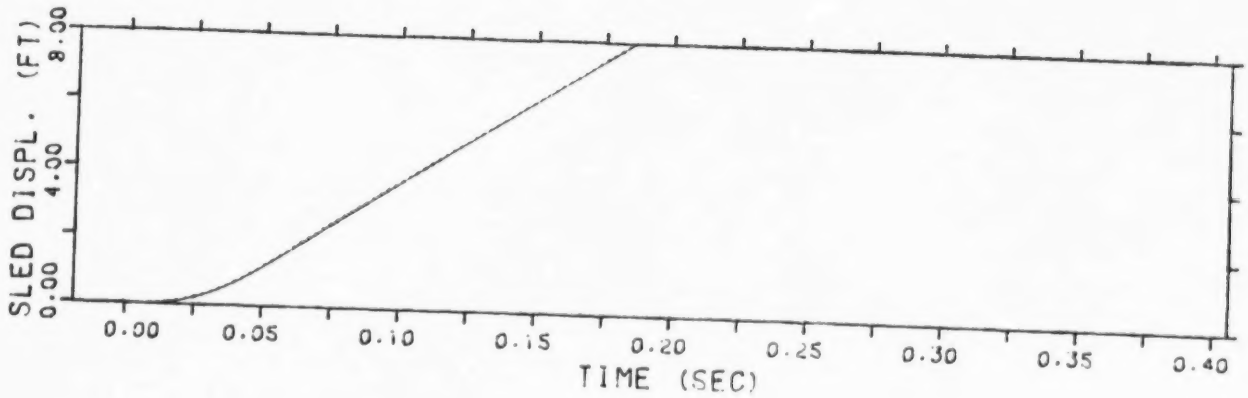


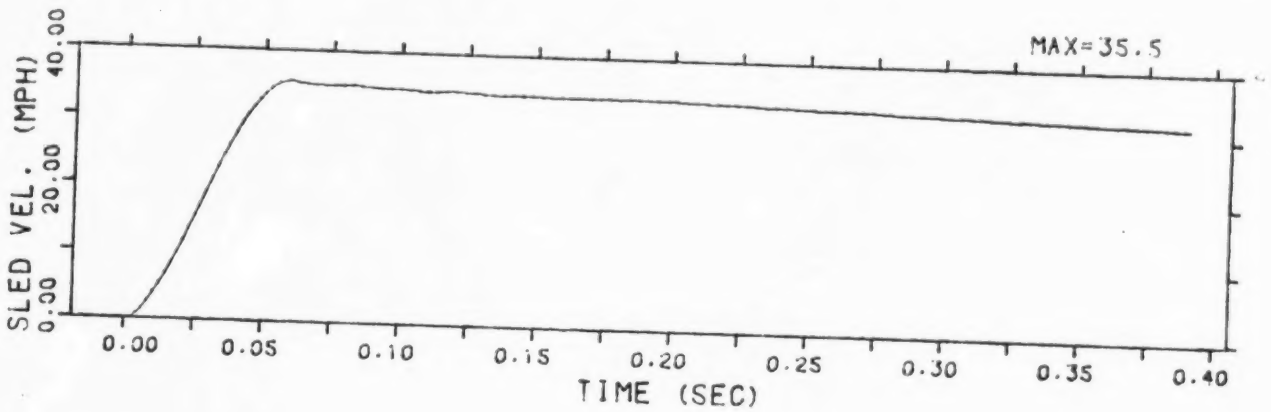

MAX=3537.3
*10^2
40.00
20.00
0.00
BELT LD. (LB)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

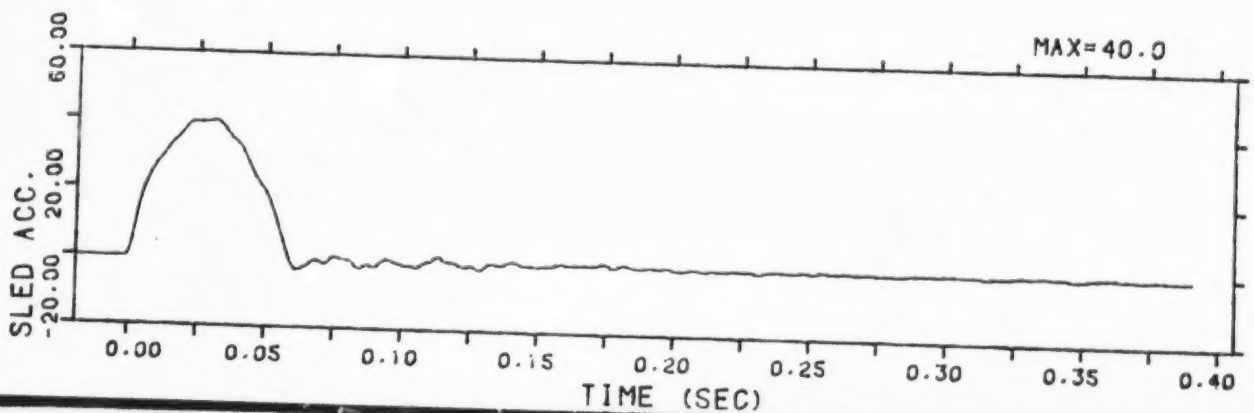
DCIEM IMPACT STUDIES FACILITY

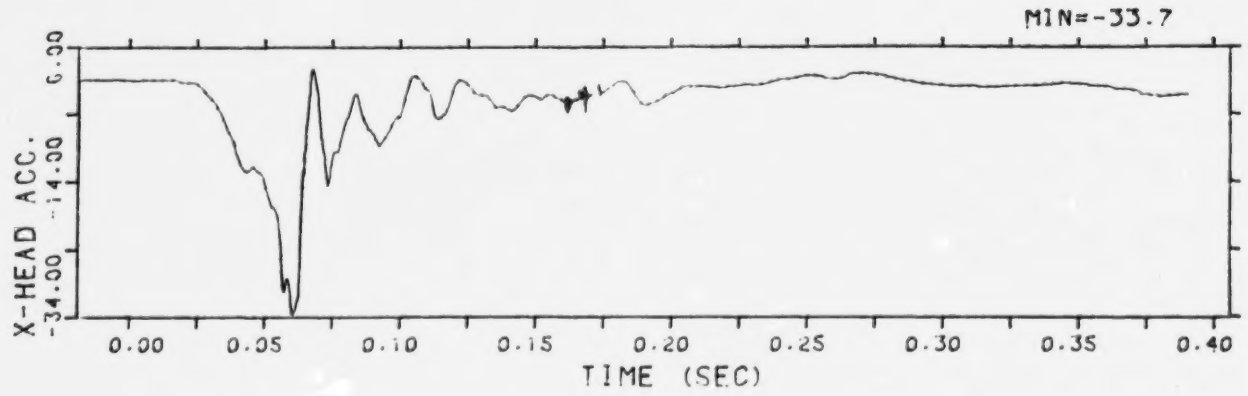
DK:T3F373.DAT

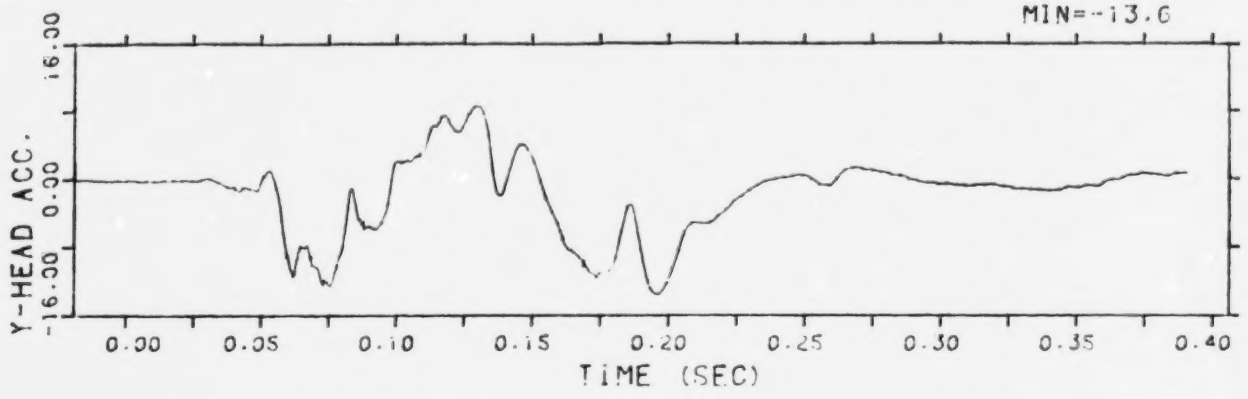
24-AUG-82

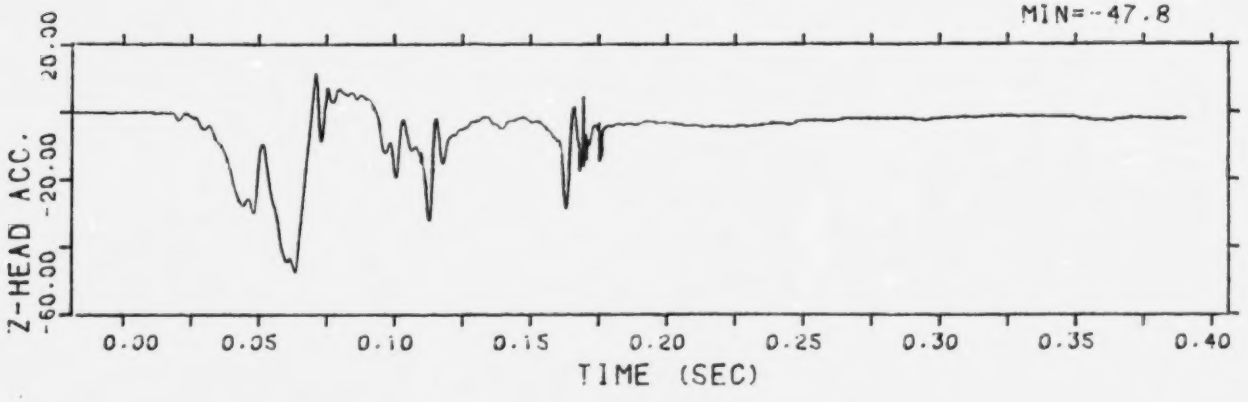


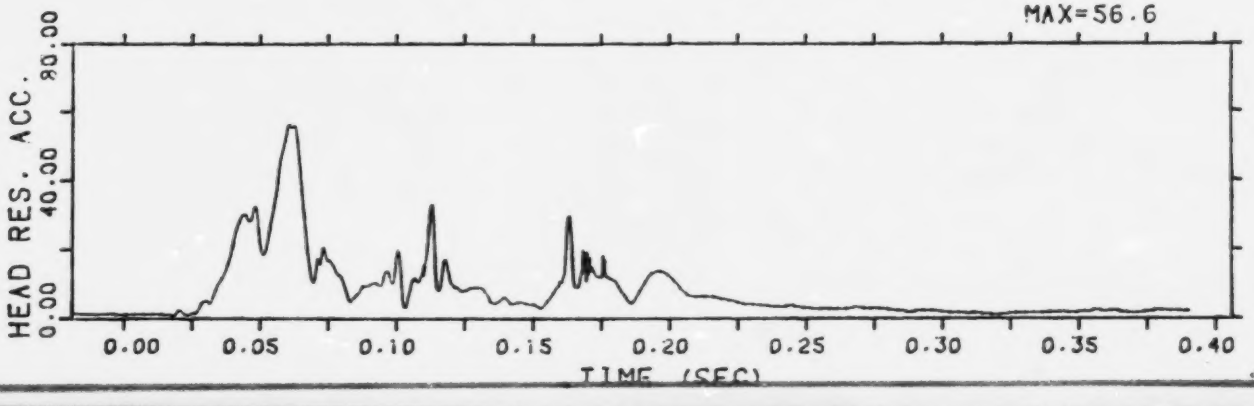


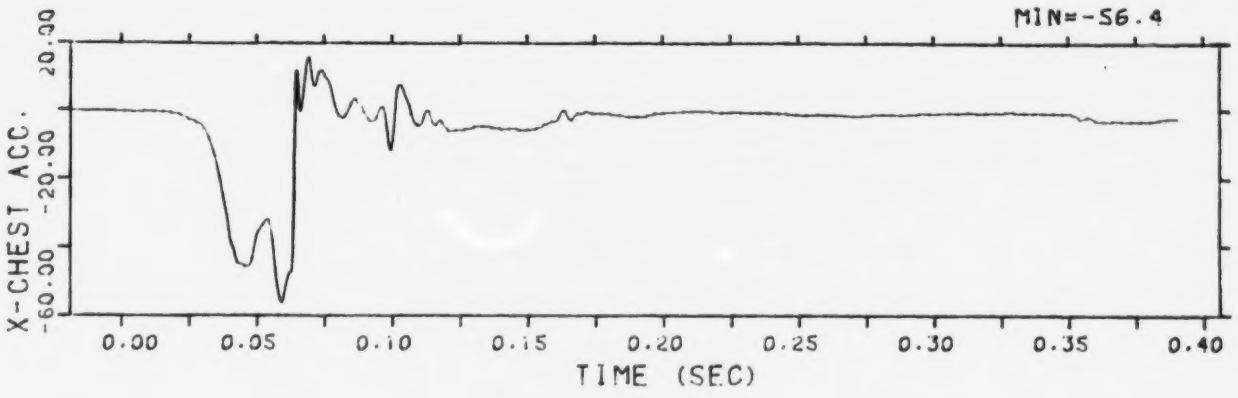


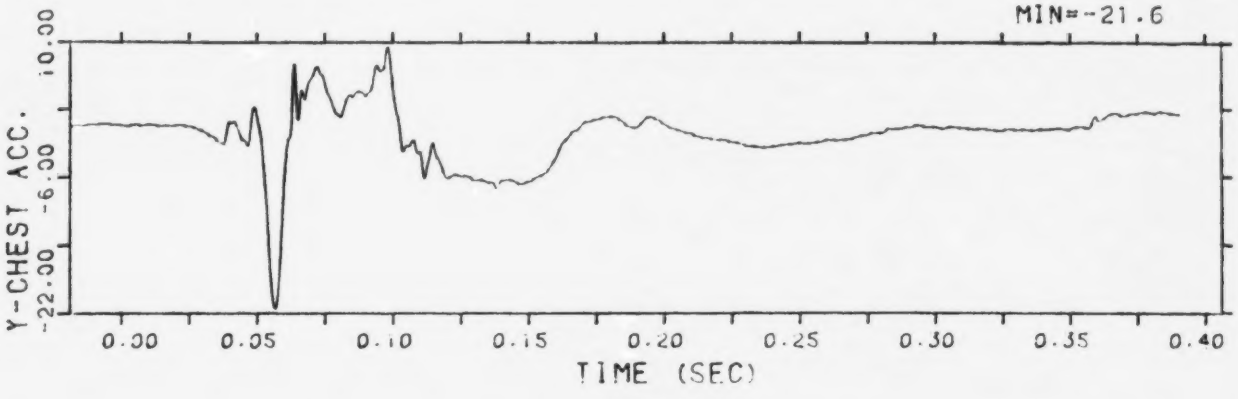

MIN=-33.7
X-HEAD ACC.
6.00
-14.00
-34.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

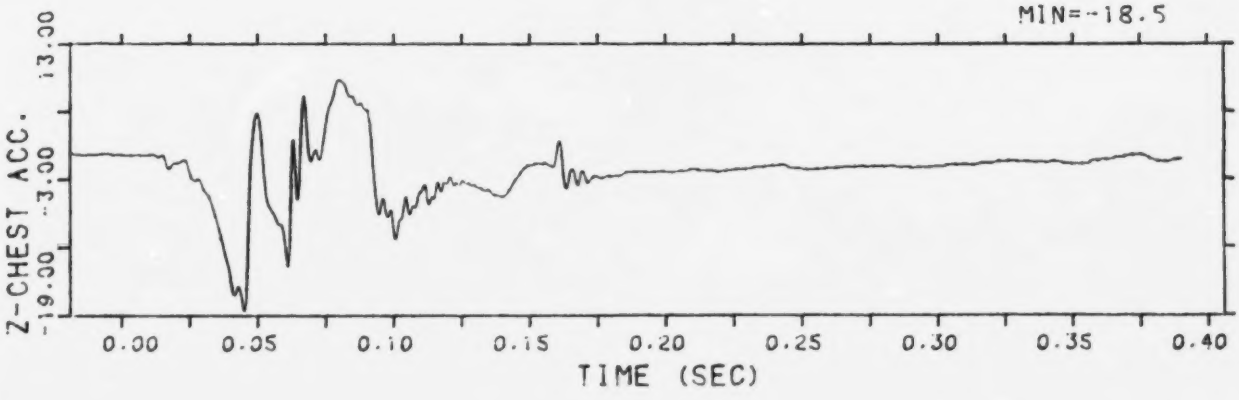

MIN=-13.6
Y-HEAD ACC.
16.00
0.00
-16.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

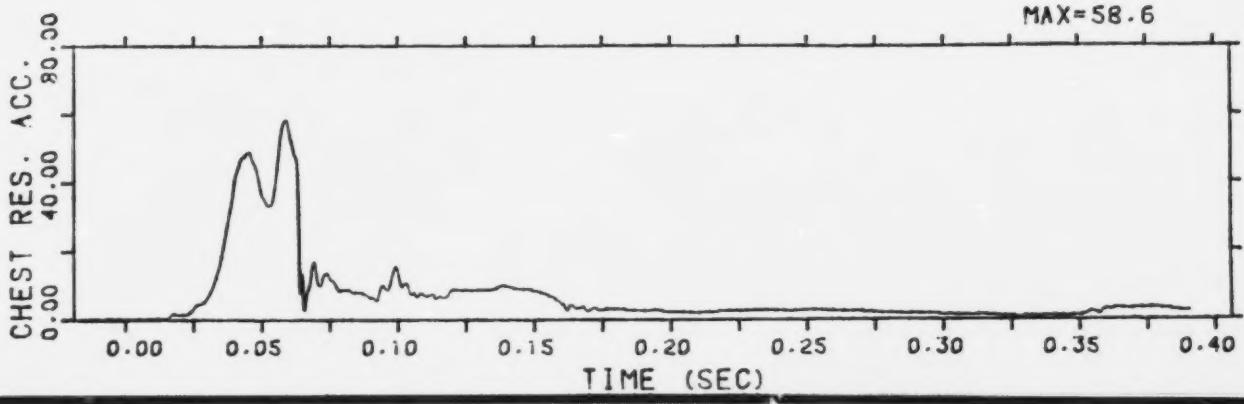

MIN=-47.8
Z-HEAD ACC.
20.00
-20.00
-60.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

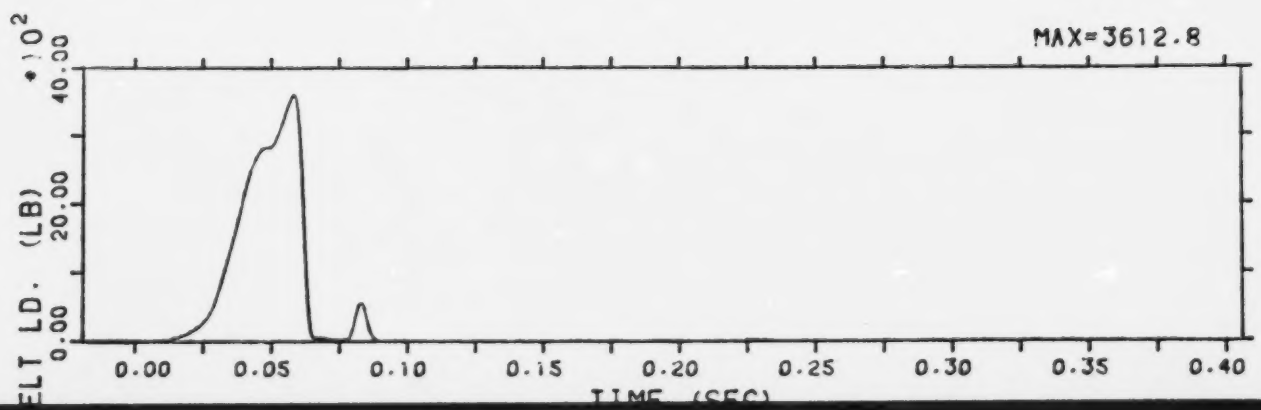

MAX=56.6
HEAD RES. ACC.
80.00
40.00
0.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)


MIN=-56.4
X-CHEST ACC.
20.00
-20.00
-60.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)


MIN=-21.6
Y-CHEST ACC.
10.00
-6.00
-22.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)


MIN=-18.5
Z-CHEST ACC.
13.00
-3.00
-19.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

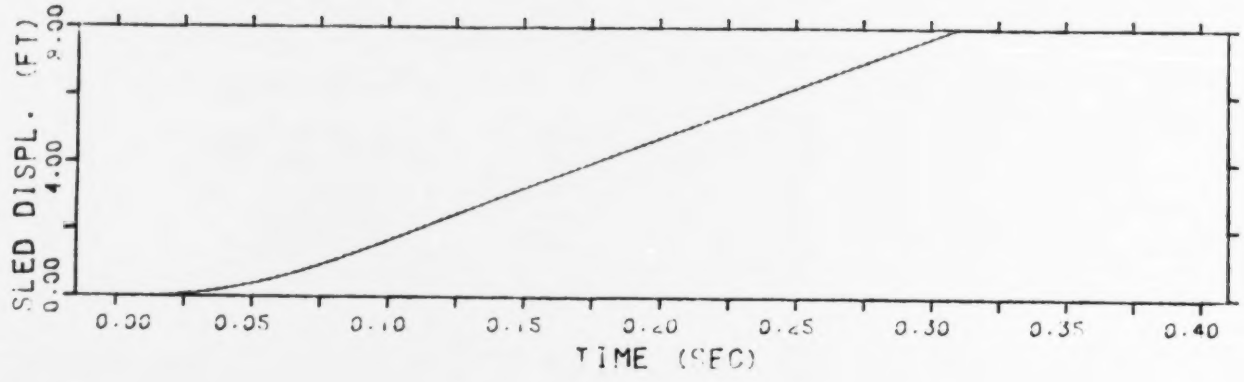

MAX=58.6
CHEST RES. ACC.
80.00
40.00
0.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

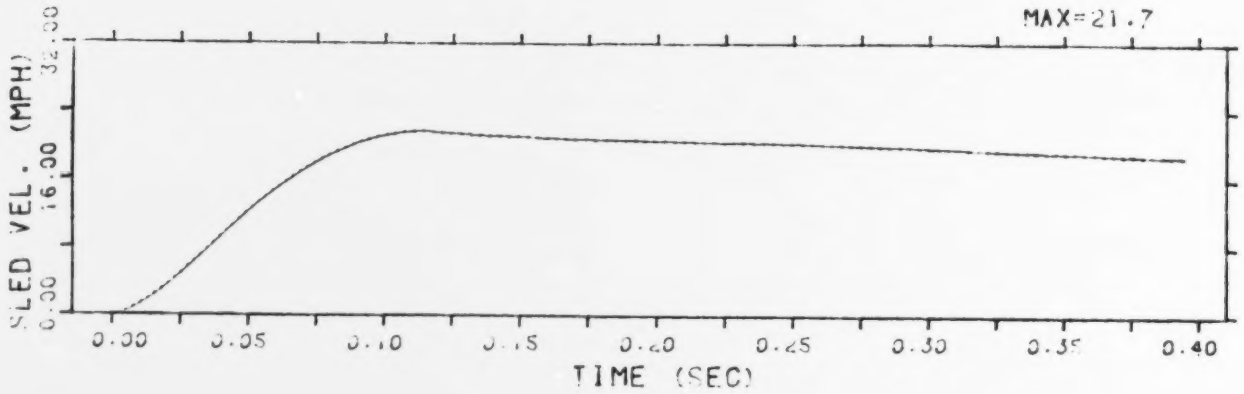

MAX=3612.8
*10^2
40.00
20.00
0.00
ELT LD. (LB)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

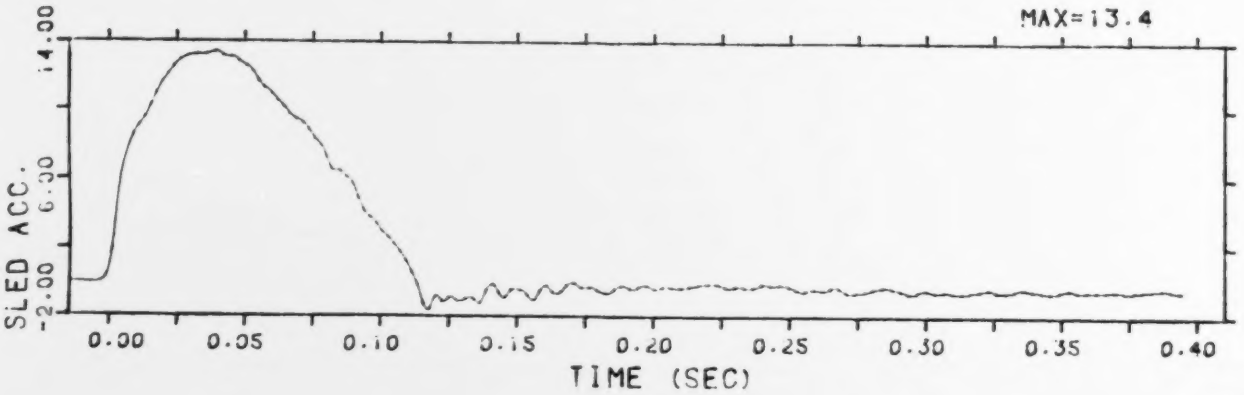
DCIEM IMPACT STUDIES FACILITY

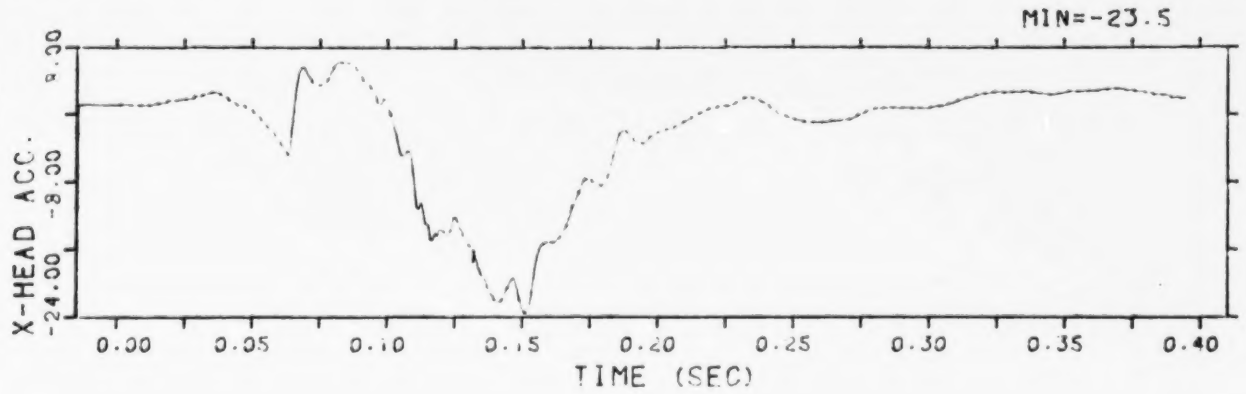
DK:T33374.DAT

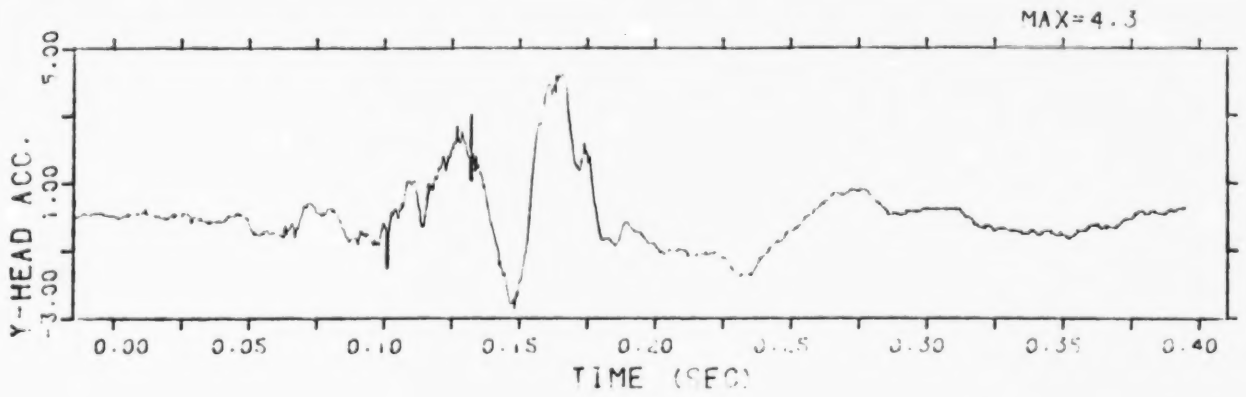
25-AUG-82

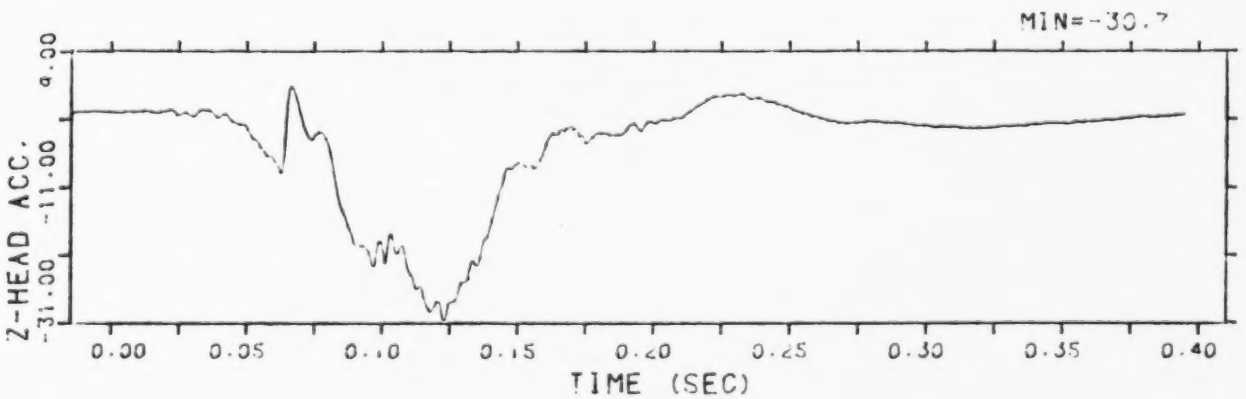


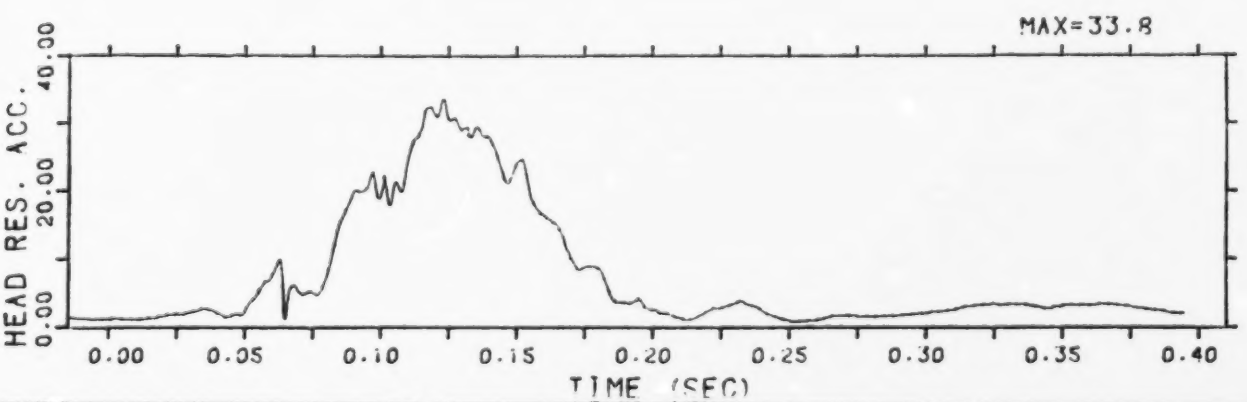




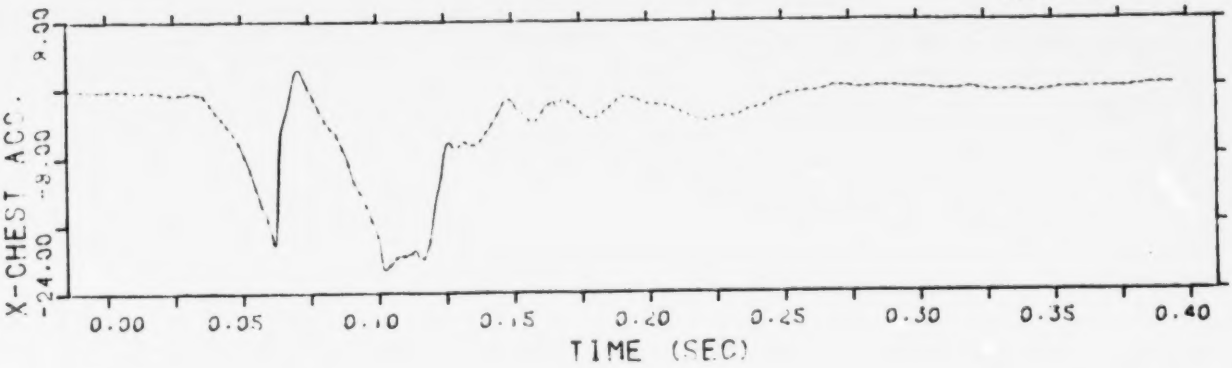

MIN=-23.5
X-HEAD ACC.
8.00
-8.00
-24.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)


MAX=4.3
Y-HEAD ACC.
5.00
1.00
-3.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

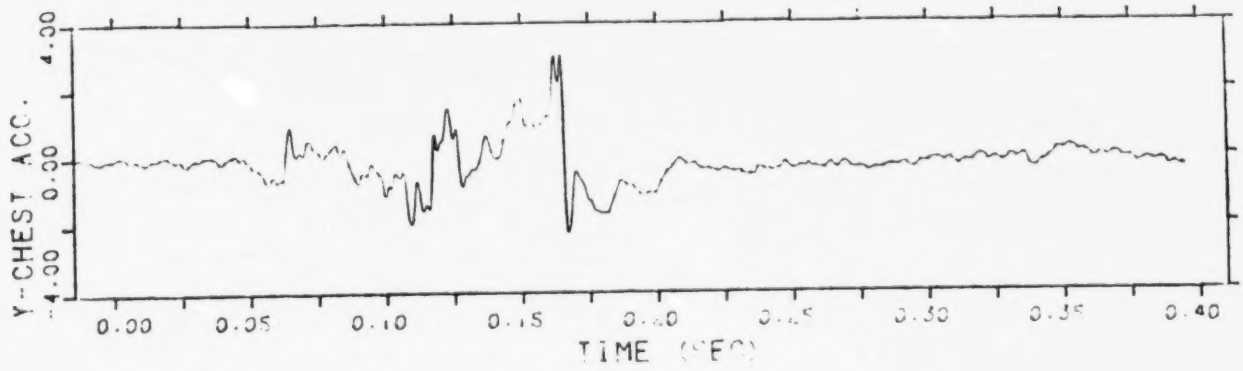

MIN=-30.7
Z-HEAD ACC.
8.00
-11.00
-31.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)


MAX=33.8
HEAD RES. ACC.
40.00
20.00
0.00
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
TIME (SEC)

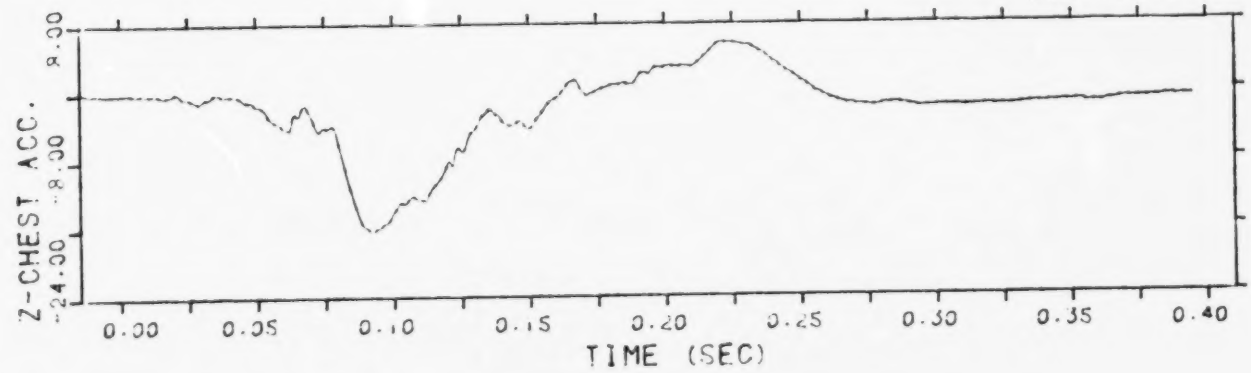
MIN=-21.3



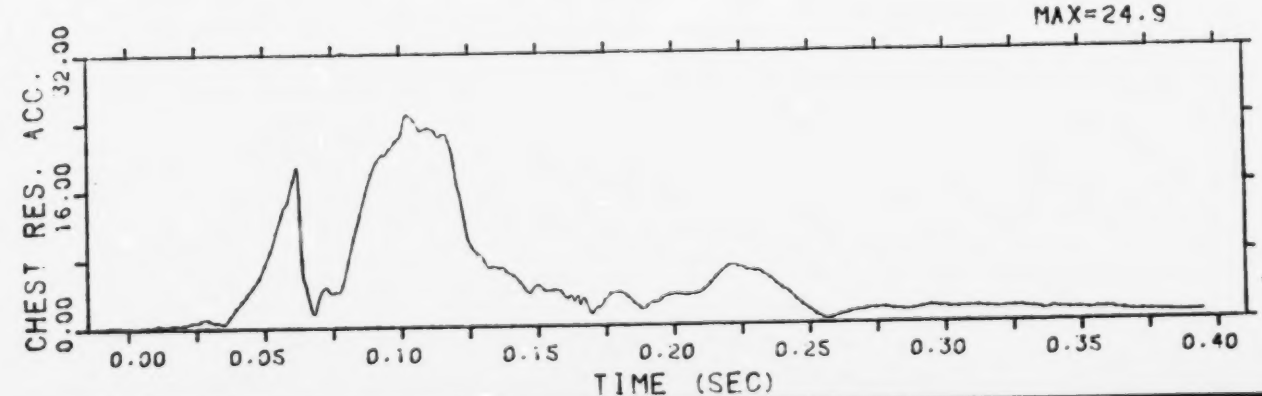
MAX=3.1

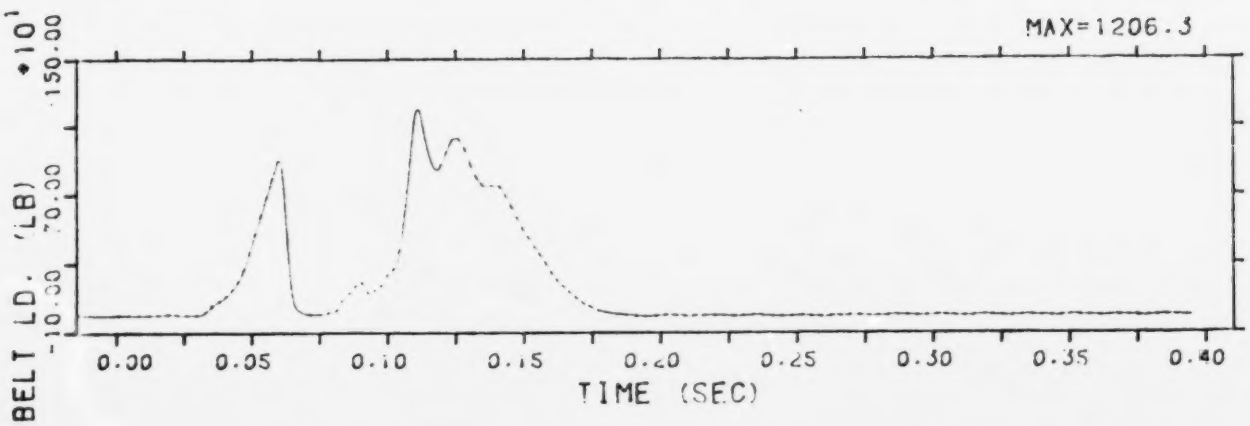


MIN=-16.3



MAX=24.9

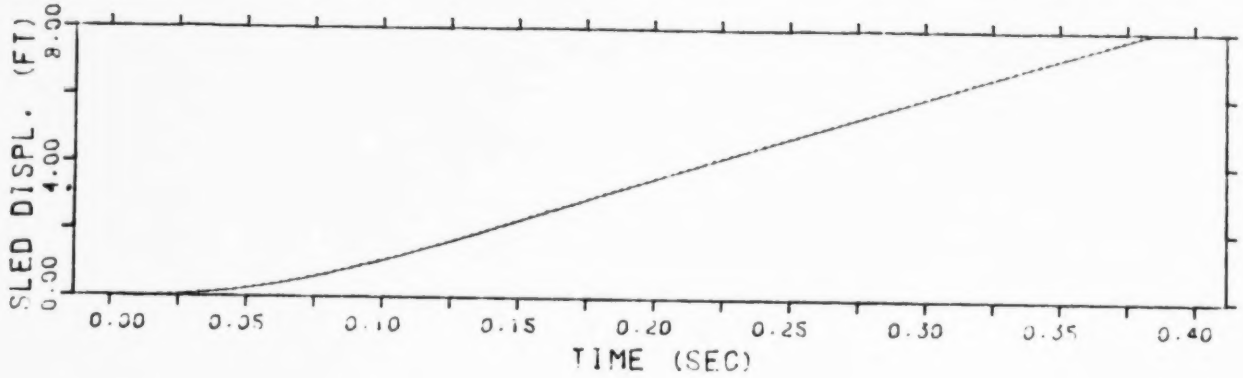


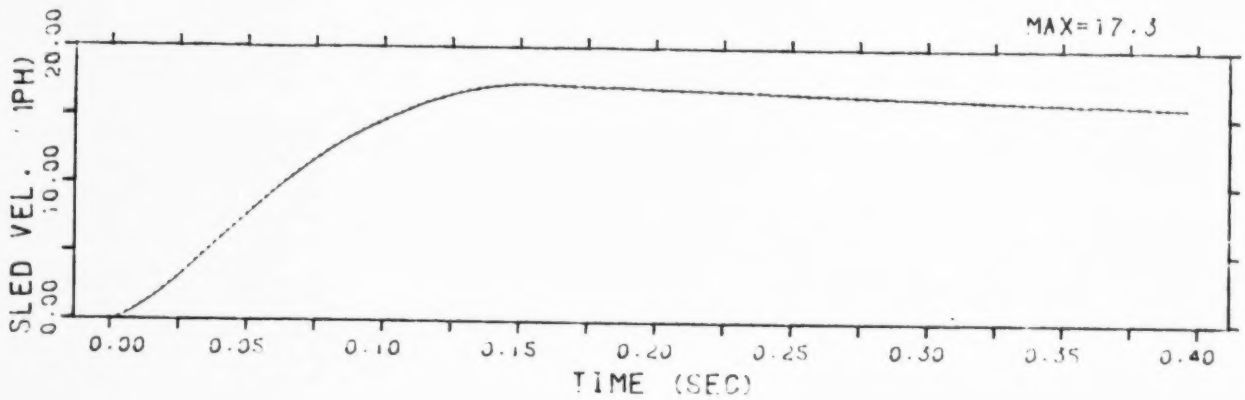

MAX=1206.3
BELT LD. (LB) *10¹
150.00
70.00
-10.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

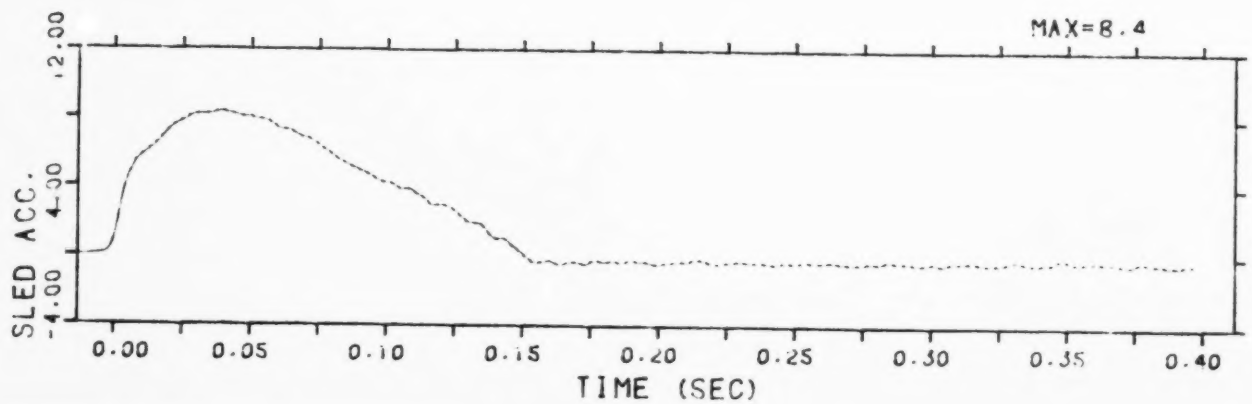
DCIEM IMPACT STUDIES FACILITY

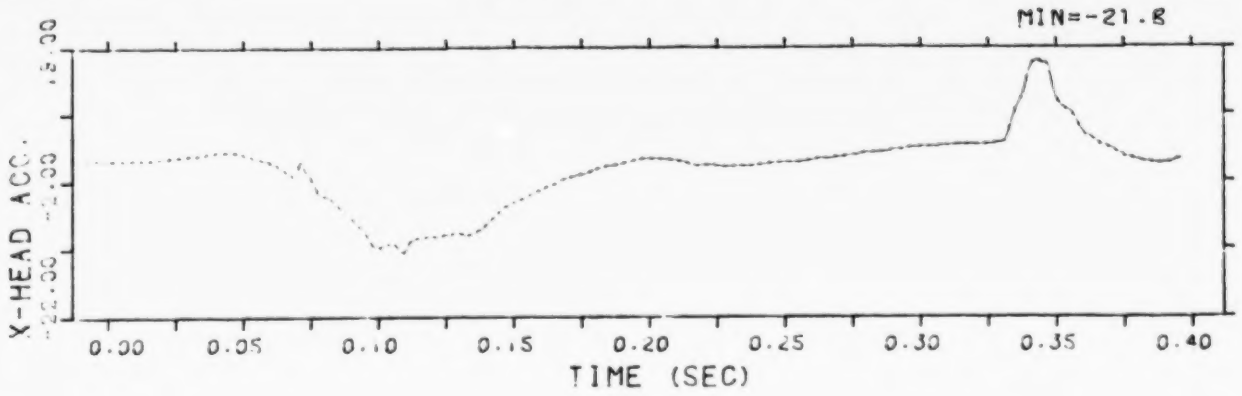
DK:T33375.DAT

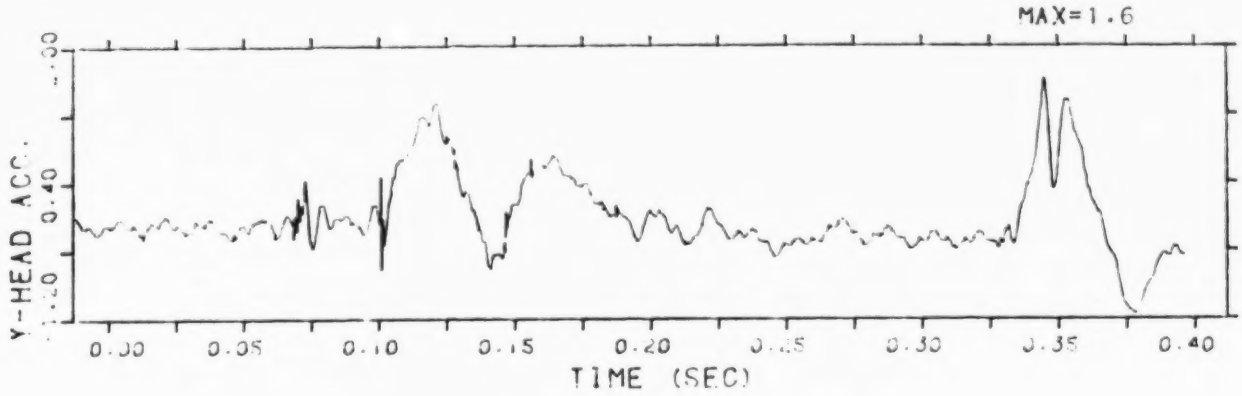
25-AUG-82

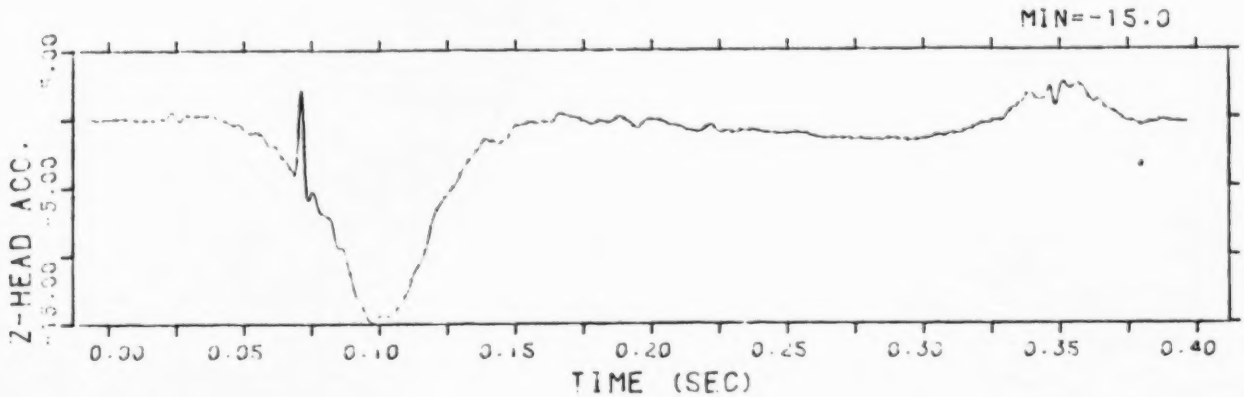


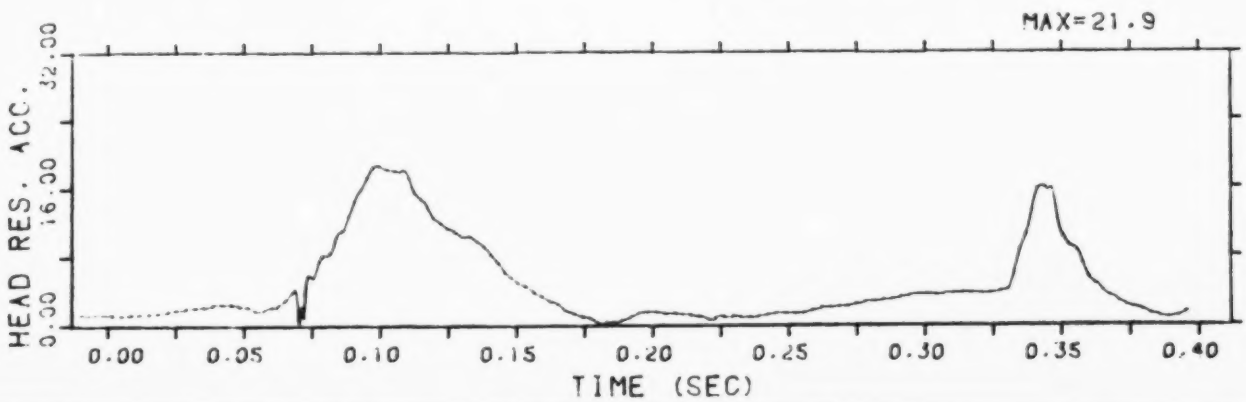


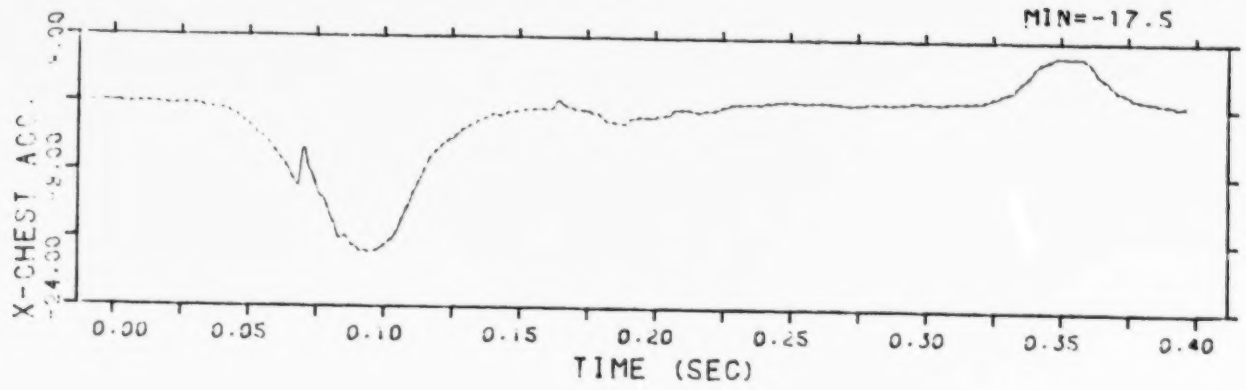


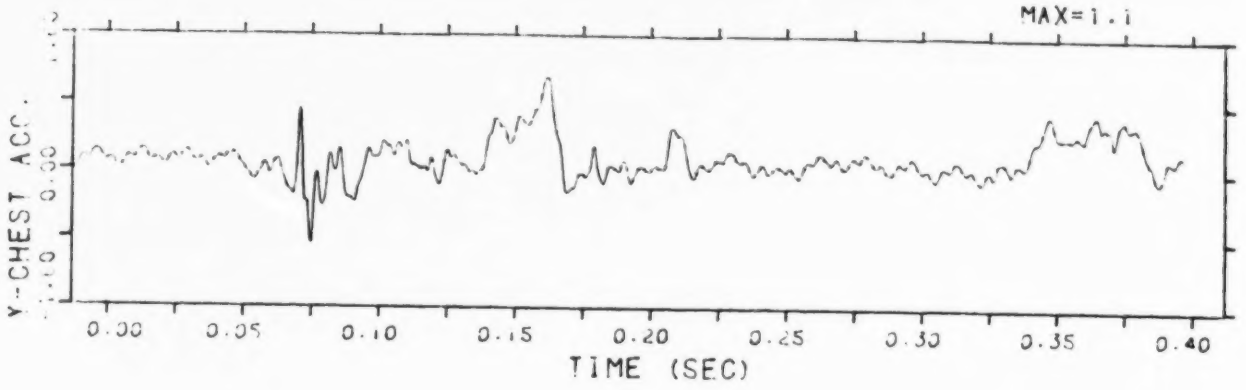

MIN=-21.8
X-HEAD ACC.
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

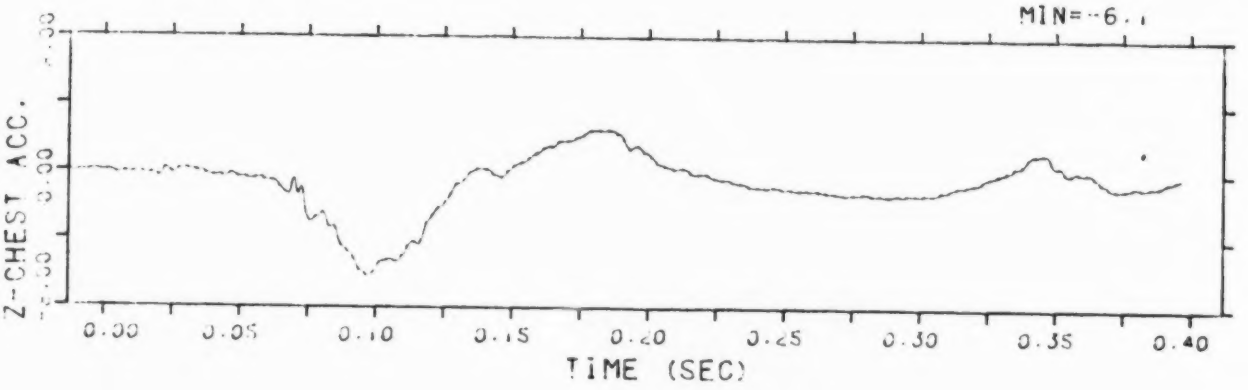

MAX=1.6
Y-HEAD ACC.
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

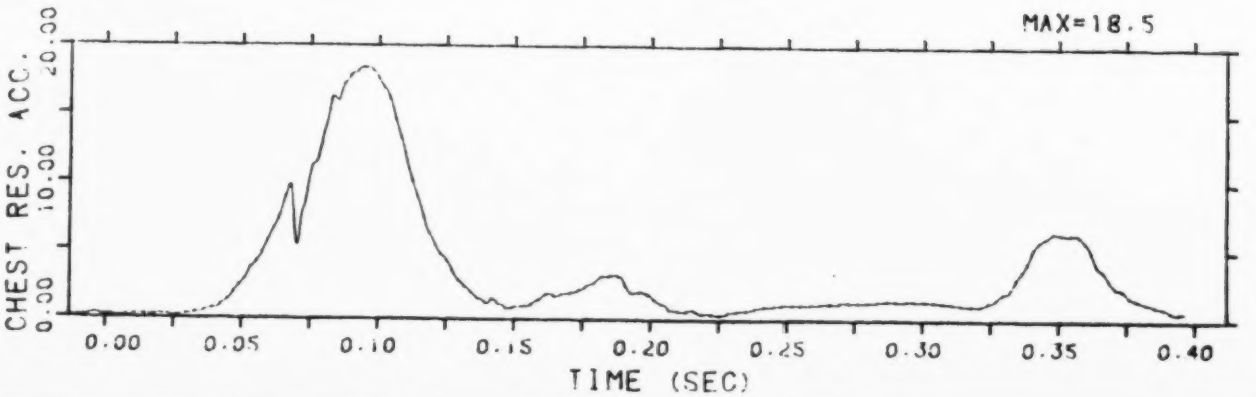

MIN=-15.0
Z-HEAD ACC.
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

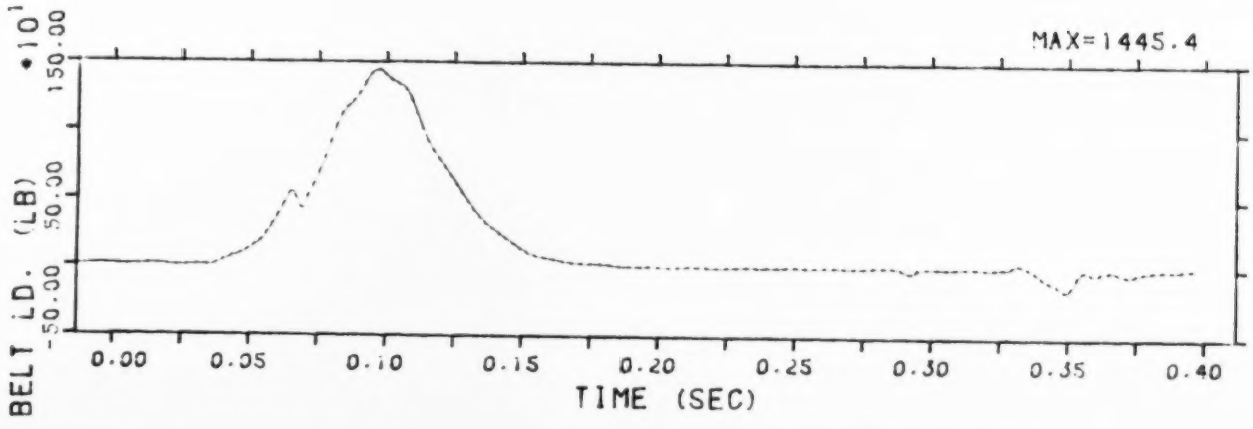

MAX=21.9
HEAD RES. ACC.
32.00
16.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)


MIN=-17.5
X-CHEST ACC.
-24.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)


MAX=1.1
Y-CHEST ACC.
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)


MIN=-6.1
Z-CHEST ACC.
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

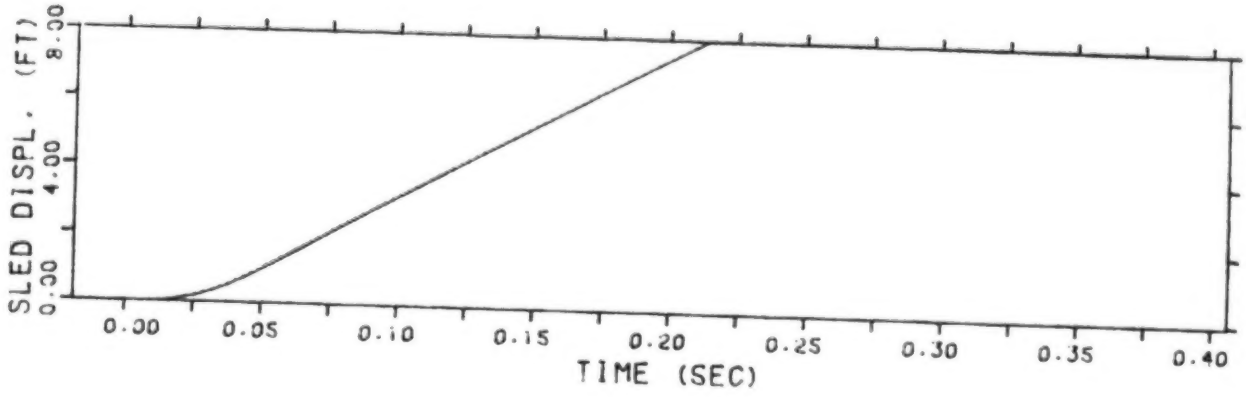

MAX=18.5
CHEST RES. ACC.
0.00
10.00
20.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

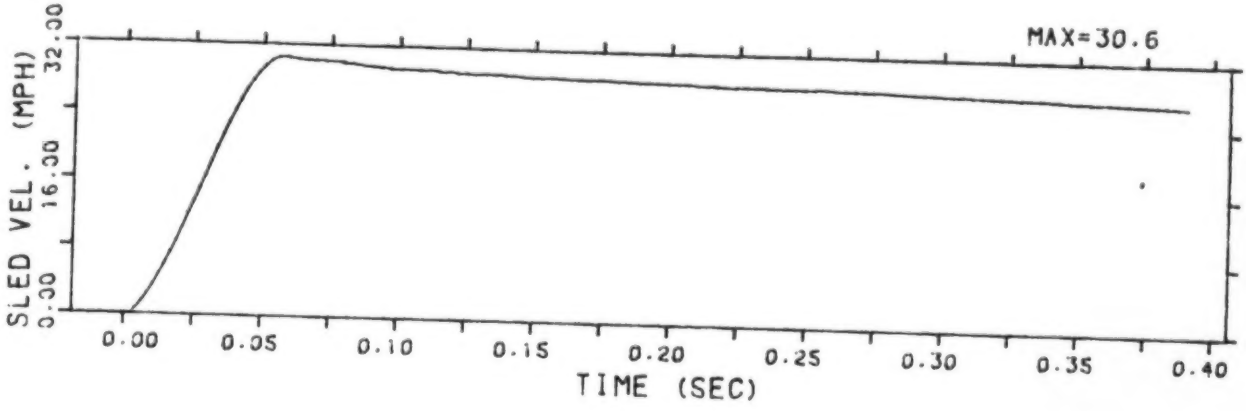

MAX=1445.4
•10¹
150.00
50.00
-50.00
BELT L.D. (LB)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

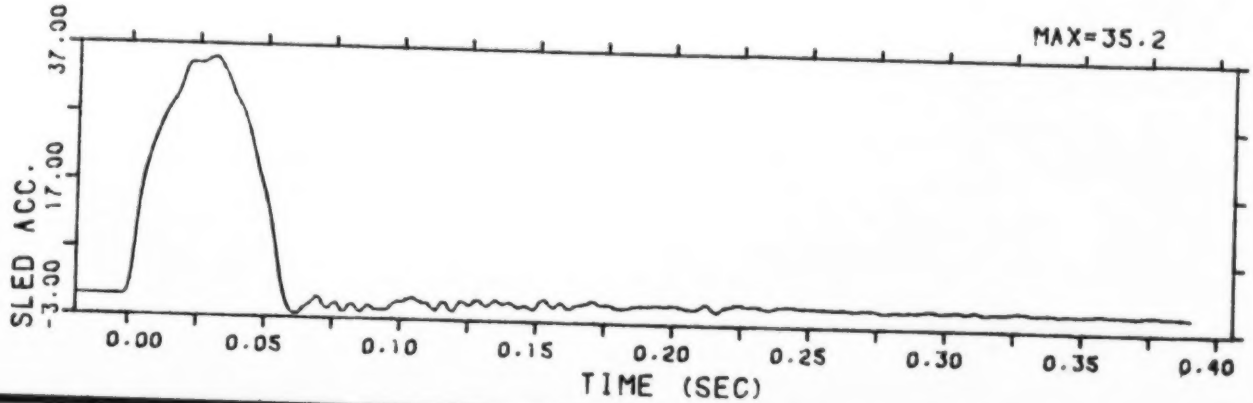
DCIEM IMPACT STUDIES FACILITY

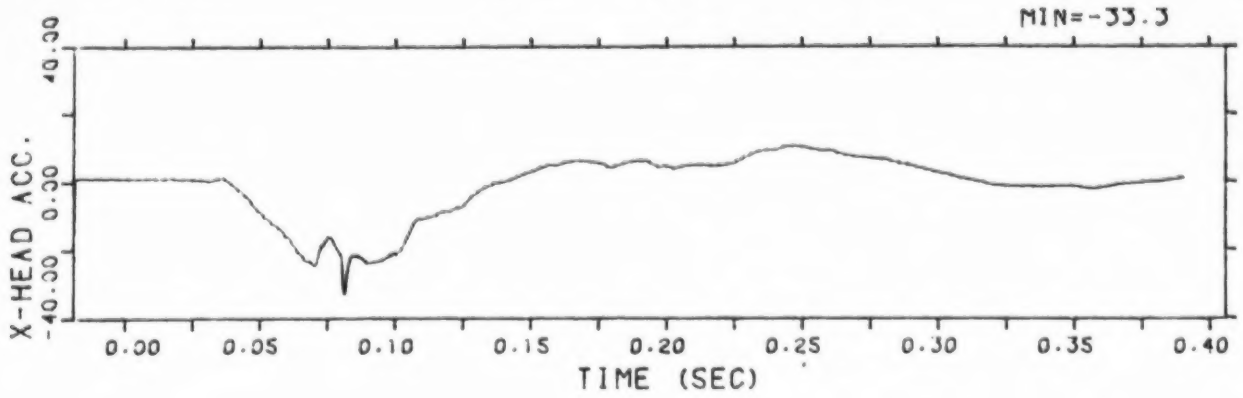
DK:T3F376.DAT

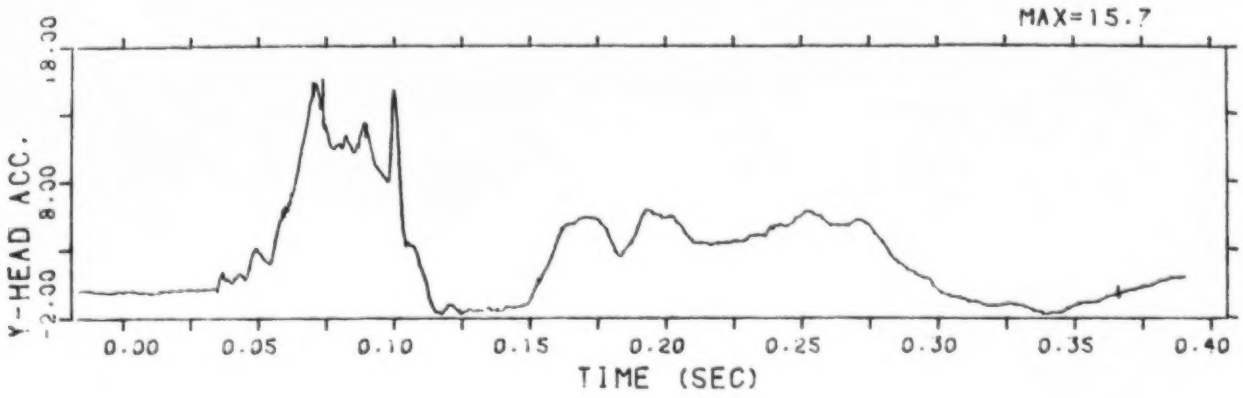
26-AUG-82

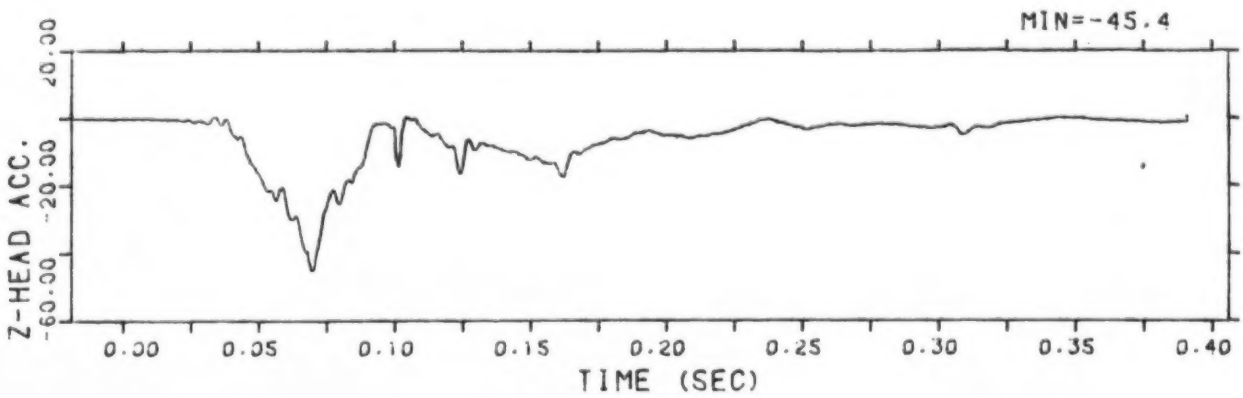


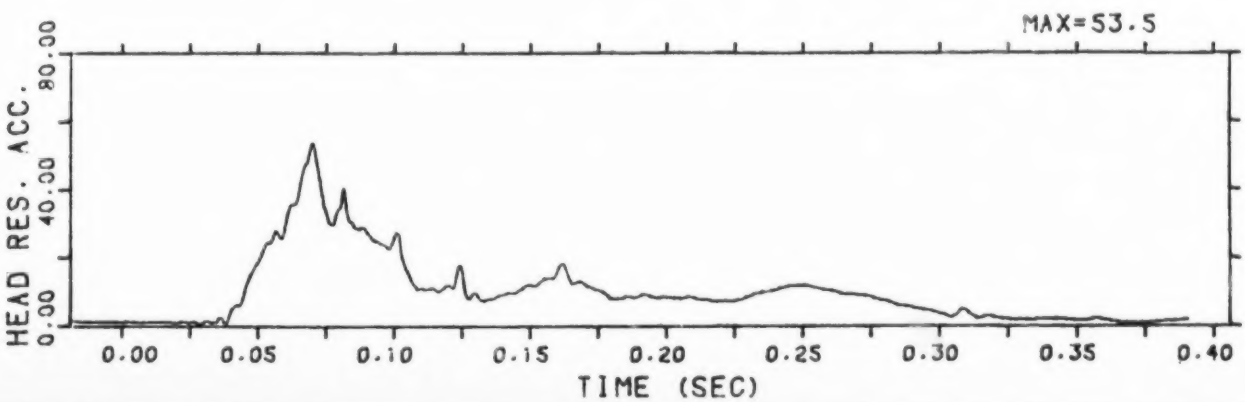





MIN=-33.3
X-HEAD ACC.
40.00
0.00
-40.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)


MAX=15.7
Y-HEAD ACC.
18.00
8.00
-2.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

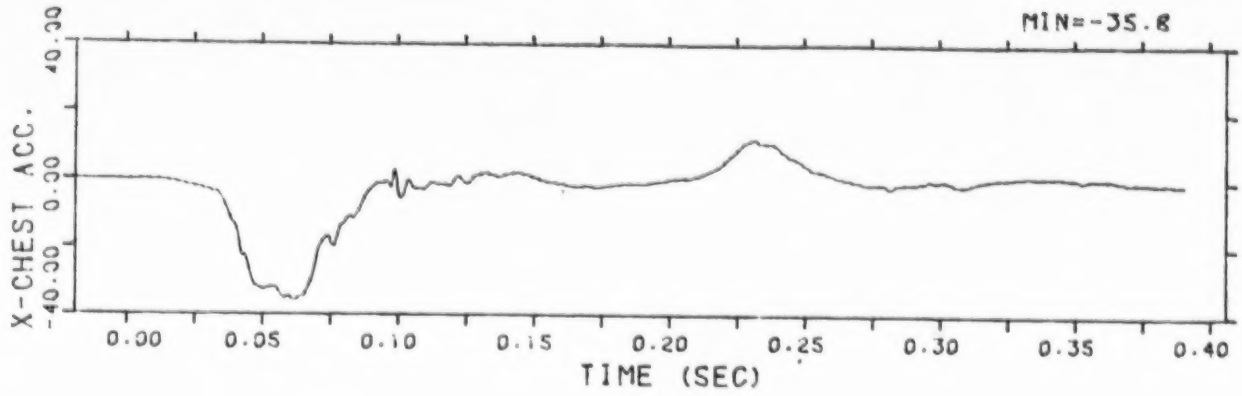

MIN=-45.4
Z-HEAD ACC.
20.00
-20.00
-60.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

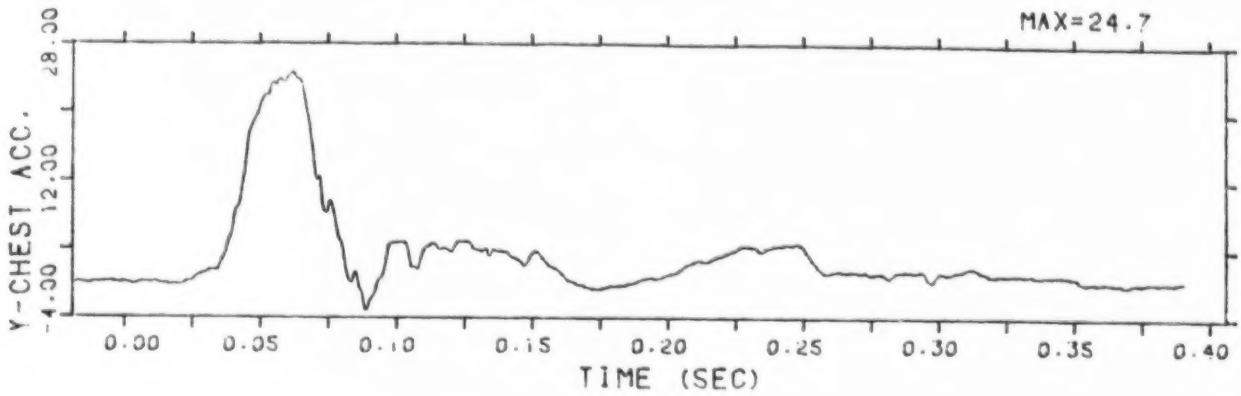

MAX=53.5
HEAD RES. ACC.
80.00
40.00
0.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

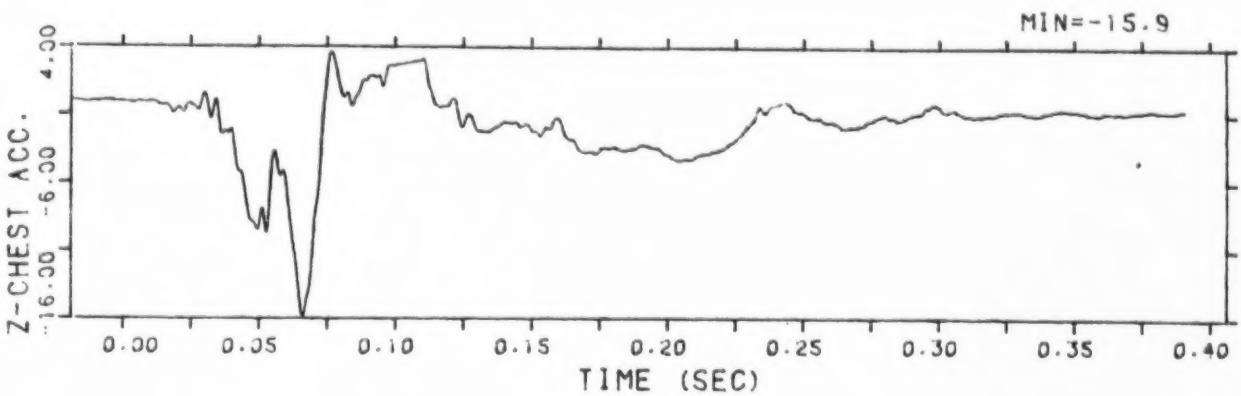
DK:T3F376.DAT

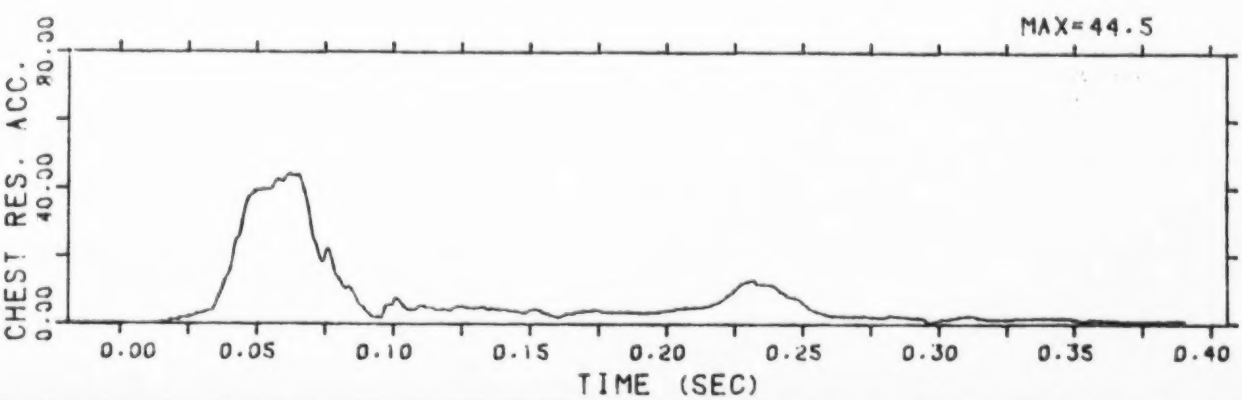
SHOULDER BELT 1 D

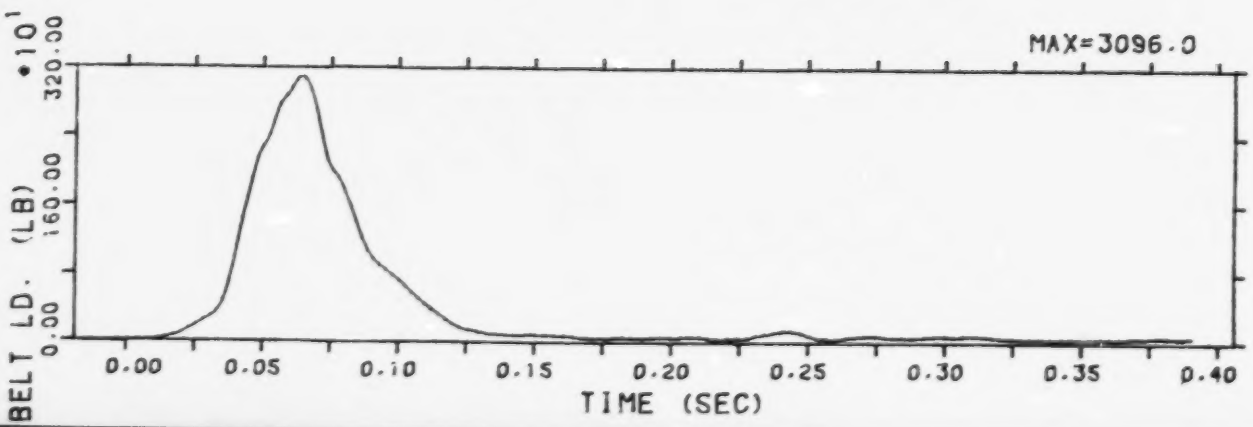
CHEST ACCEL.










MAX=3096.0
•10¹
320.00
160.00
0.00
BELT LD. (LB)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
TIME (SEC)

POOR

QUALITY

ORIGINAL